THE PRACTICAL DICTIONARY OF MECHANICS

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PLATE IX.

OVER THE RIVER DNEIPER, AT KIEFF, RUSSIA.

See page 518

THE

PRACTICAL

DICTIONARY OF MECHANICS:

BEING

A DESCRIPTION OF TOOLS, INSTRUMENTS, MACHINES, PROCESSES, AND ENGINEERING; HISTORY OF INVENTIONS; GENERAL TECHNOLOGICAL VOCABULARY;

AND

DIGEST OF MECHANICAL APPLIANCES IN SCIENCE AND THE ARTS.

By EDWARD H. KNIGHT,

CIVIL AND MECHANICAL ENGINEER, ETC., U.S.

Illustrated

WITH UPWARDS OF FIVE THOUSAND ENGRAVINGS.

DIVISION II.

"Thus Time brings all things, one by one, to sight,
And Skill evolves them into perfect light."

LUCRETIUS, Book V.

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b has the usual elliptical springs between the bolster and axle.

c has elastic wooden springs which connect the axles and also support the bed.

d has semi-elliptical springs which also couple the axles.

e has a bolster hung upon C-springs.

f has a system of curved springs with three points of connection to the bed and two to the axles.

Car'riage-step. A step, usually on a jointed dependent frame, to afford means for mounting into a carriage.

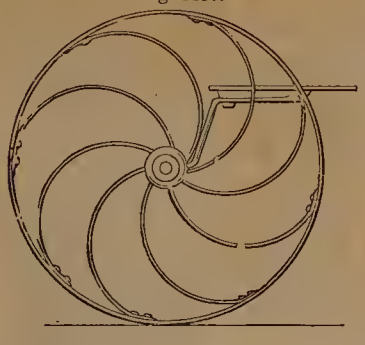
A carriage-step to be let down and raised by the opening and closing of the carriage-door was patented in England by Thomason in 1799.

Car'riage-top. 1. The cover of a carriage. Permanent in coaches; double calash in barouches and landaus; calash in some gigs, buggies, phaetons, etc.; curtained in ambulances and spring-wagons.

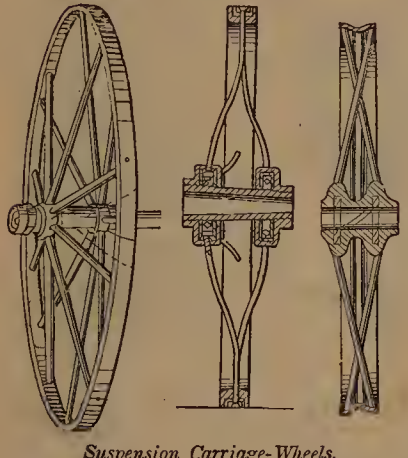
2. A shifting-rail on the back and ends of a buggy-seat, to make a high-back, or, by removal, a low-back buggy.

Car'riage-wheel. This has usually a hub or nave, spokes, fellies, and tire. A box fitted in the hub runs in contact with the spindle or arm of the axle, and the wheel is held on the spindle by a linch-pin, nut, or other device.

Fig. 1137.



Carriage-wheels are variously constructed. In the usual form the radial spokes are planted in the hub and distend the rim. In the *suspension*-wheel, so called, the cast-iron hub and wrought-iron rim are connected by rods tightened by nuts.



Suspension Carriage-Wheels.

The illustration gives several forms of the suspension-wheel. The upper figure has curved steel spokes, which provide in the wheels the spring or elasticity necessary for the vehicle.

The other figures show modes of securing the rims to the hubs by curved, crossed, or broad-based spokes. The run of improvement now is in the hubs and the modes of securing the spokes therein. See HUB; SPOKE; FELLY.

Car'rick-bend. (*Nautical.*) A knot formed on a bight by putting the end of a rope over its standing part, so as to form a cross; reeve the end of the other rope through the bight, up and over the cross and down through the bight again, on the opposite side from the other end. See BEND.

Car'rick-bitts. (*Shipbuilding.*) The vertical posts or cheeks which support the barrel of the windlass.

Car'rier. (*Turning.*) 1. A *driver* in a lathe, to impel the object which is supported on the *front* and *back* spindles, otherwise called the *live* and *dead* spindles. It is attached by a set-screw to the shaft to be turned, or to a mandrel on which a round object is driven for the purpose of being turned. The carrier is driven around by a projection on the *center-chuck* or *face-plate*. A *lathe-dog*.

2. A distributing-roller in a carding-machine.

3. A roller between the drum and the feeding-rollers of a *scribbling*-machine for spinning wool.

4. A spool or bobbin-holder in a braiding-machine which follows in the curved path which intersects the paths of other bobbins, and thus lays up the threads into a braid. See BRAIDING-MACHINE.

Car'ron-ade'. A short, light species of cannon intended for firing solid shot at short ranges, with comparatively small charges.

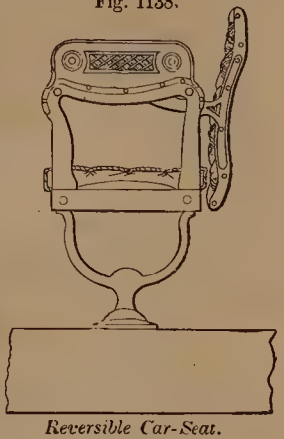
It has no trunnions, but is secured to its carriage by a bolt passing through a lug or "navel" cast on its under side. This form of gun was formerly much used on shipboard, but is now nearly obsolete.

So named from the foundry on the river Carron, Stirlingshire, Scotland, where they were first cast in 1779.

Car'ry-all. (*Vehicle.*) A light, four-wheeled family vehicle drawn by one horse.

Car-seat. A seat in a railway-car. The back is usually reversible, so as to adapt it for passengers in either direction of motion of the car, the preference being to "face the horses," as it is called. The facility for reversing is, moreover, useful in throwing two seats into a "section" for a party.

Fig. 1138.

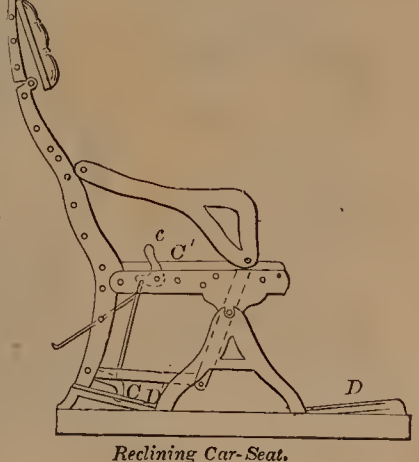


Reversible Car-Seat.

Car-seats are also made reclining, for night travel; such are termed "sleeping-chairs."

The occupant of the chair can adjust the back to any desired angle by means of a hand-lever *e*, which, on being released, allows the pawl *C* to drop into the nearest notch in the plate *D*, and hold the seat stationarily in the desired position.

Fig. 1139.



Reclining Car-Seat.

For this purpose, back, seat, and arm are pivoted together, the stationary point on which they oscillate being at the apex of the A-shaped support. As the seat slides to the rear, the back reclines, and the leg-board is projected in front.

Other car-

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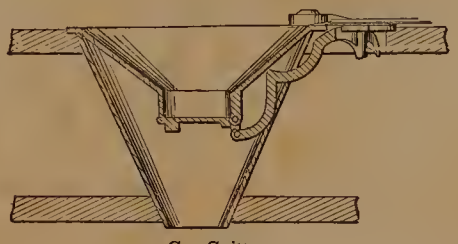
seats are capable, by addition of parts, of being transformed into couches.

Car-seat Arm-lock. (*Railway.*) A lock attached to the bar of a seat-back, to prevent its being reversed by unauthorized persons. The bolt is withdrawn by a key.

Car-spit'toon. A spittoon inserted in the floor

Fig. 1140.



Car-Spittoon.

of a car and discharging beneath. It has a valve, operated by a trigger under the control of the foot.

Car-spring. A resilient or yielding structure or material, interposed between the car and the axle to prevent the jar of the wheel being communicated to the car; or to moderate the effect of the rolling or pitching motion of the car.

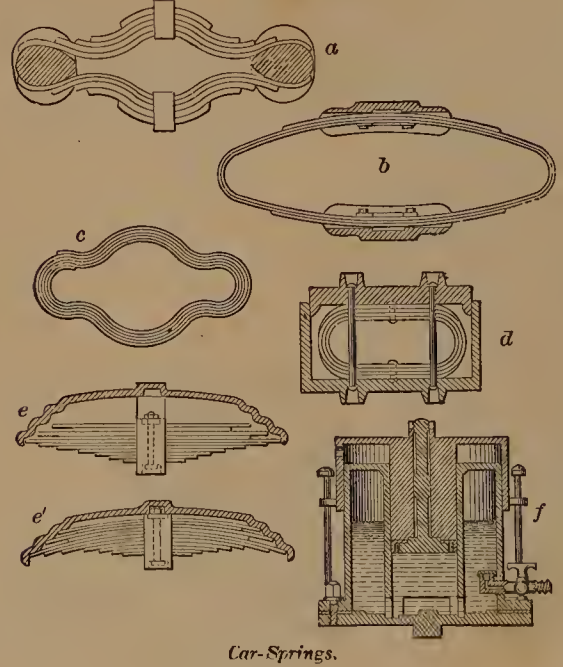
Car-springs are of various forms and materials, and are variously placed. In railway passenger-cars there are several sets, usually of different kinds, at different places between the point of jar and the car-bed. A good instance may be seen in CAR-TRUCK, where the various parts are exhibited, and the transference of the jar from one point to another is explained. See CAR-TRUCK.

Car-springs may be classed as: —

Elliptical.	Spiral.
Pneumatic.	Helical.
Torsional.	Circular plate; plane, corrugated, and segmental.
Rubber.	
Rubber and steel.	Square plate.
Rubber, steel, and air.	Bow.

In the series of illustrations the parts and structure are so evident that a short description only will be given.

Fig. 1141.



Car-Springs.

Fig. 1141, *a* is a double elliptic spring, the bearings of whose end-leaves are so shaped, that, as the spring bends beneath its load, additional leaves receive a bearing upon the ovoid bars.

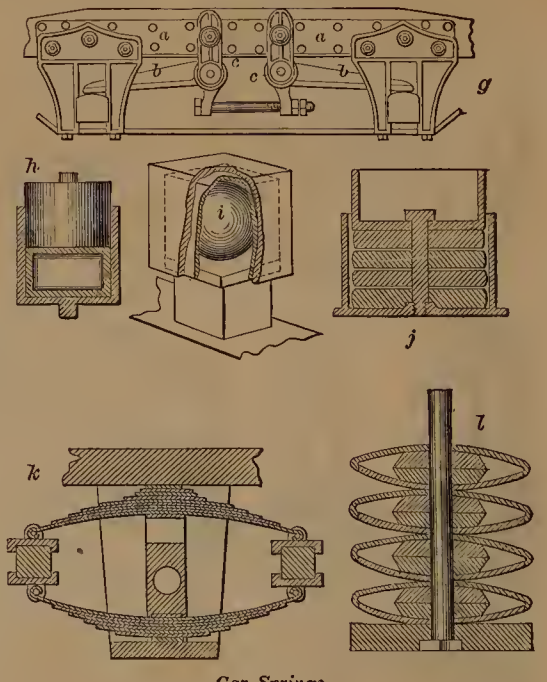
b is an elliptic spring whose principal leaves are made of a continuous plate wound round and round. Auxiliary plates above and beneath extend the area of bearing of the boxes or bars.

c is an elliptic spring made of a single plate wound around a mandrel of the shape indicated. It is designed to be used with upper and lower bars as at *b*, or in a box, as at *d*.

d shows an elliptic spring in a box, and a follower above, upon which the weight is imposed. The position of the spring, in the box, is maintained by bolts, and the upward motion of the follower is restrained by two long bolts as shown. These keep the followers from bouncing out of the box.

e shows a series of plates which assume the elliptical form *e'* when the weight bears upon them heavily. The box above the spring has a series of steps beneath, adapted to the lengths of the leaves of the spring, so that as the weight increases additional leaves obtain bearings in the box. The ob-

Fig. 1142.



Car-Springs.

ject is to give elasticity with light loads and strength for heavy loads, by bringing additional plates into work as the load increases. This feature of cumulative parts is found in several other forms of springs, which will be noticed in turn.

f is one form of pneumatic spring, in which the weight is imposed upon a box whose central plunger bears upon the surface of the water in the lower box. A body of air is imprisoned in the annular portion of the lower box, and is compressed by the pressure on the water, the latter serving merely as an interposed material to transfer the pressure, as in the air-compressing machines (Figs. 71 and 72, p. 32). The central rod has a disk on its lower end, which is tightened by a screw against the lower end of the plunger, to compact the packing.

In Fig. 1142, *g* is a torsional spring, in which the weight of the truck-frame *a* is thrown upon spring-rods, which are placed transversely beneath

the truck. The ends of these rods are shown at *c c*, and firmly attached to them are arms *b b*, whose ends rest on bearing-blocks above the axles. As the truck-frame sinks with its superincumbent load, a torsional pressure is brought upon the rods and by them transferred to the axle-boxes.

h is a pneumatic spring in which the air is contained in an india-rubber bag in the box, forming an air-cushion beneath the follower.

i is a hollow india-rubber ball in a box with a polished interior.

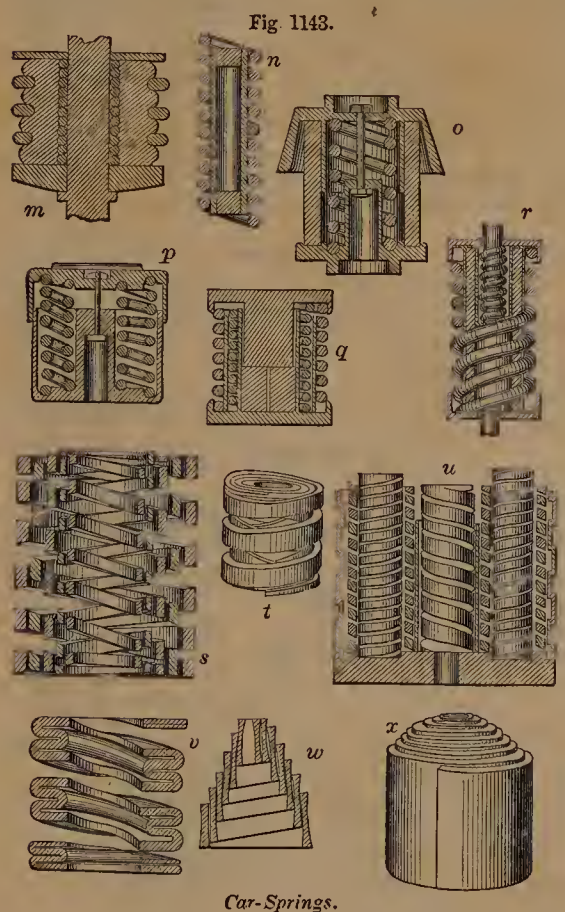
j has a number of disks of india-rubber or cork in the box, beneath the follower.

k has a combination of steel elliptic springs, with auxiliary rubber blocks at the ends.

l has concavo-convex plates fitted upon a spindle, with interposed vulcanized india-rubber disks. The plates are cruciform in plan.

In Fig. 1143, *m* is a compound spring, having a cylinder of vulcanized rubber, with an interior coil

Fig. 1143.



Car-Springs.

to keep it from binding against the spindle, and an exterior spiral coil to keep it from spreading too far. The illustration shows it in its compressed condition.

n is a spring of combined steel, rubber, and air. The air is inclosed in the rubber tube, and the latter yields with the spiral envelope to the imposed weight.

o has an india-rubber cylinder inclosing a spiral steel spring, and having a bolt, to limit the extent of upward movement of the cover. The flanged rim of the cover affords a bell-mouth, into which the rubber expands.

p has the spiral steel spring contained in an annular case.

q has a pair of concentric spiral springs on the respective sides of a dividing-cylinder. In the illustration, the spring is shown as extended, in which position the follower is not in contact with the rubber cylinder, so that the latter comes in as auxiliary to the spiral screws when they have attained a certain point of depression.

r is a combination of spiral and rubber springs, with telescopic tubes which form walls.

s is a concentric arrangement of several spiral springs coiled in diverse directions alternately.

t shows a closer coil of the same general construction, but different proportions.

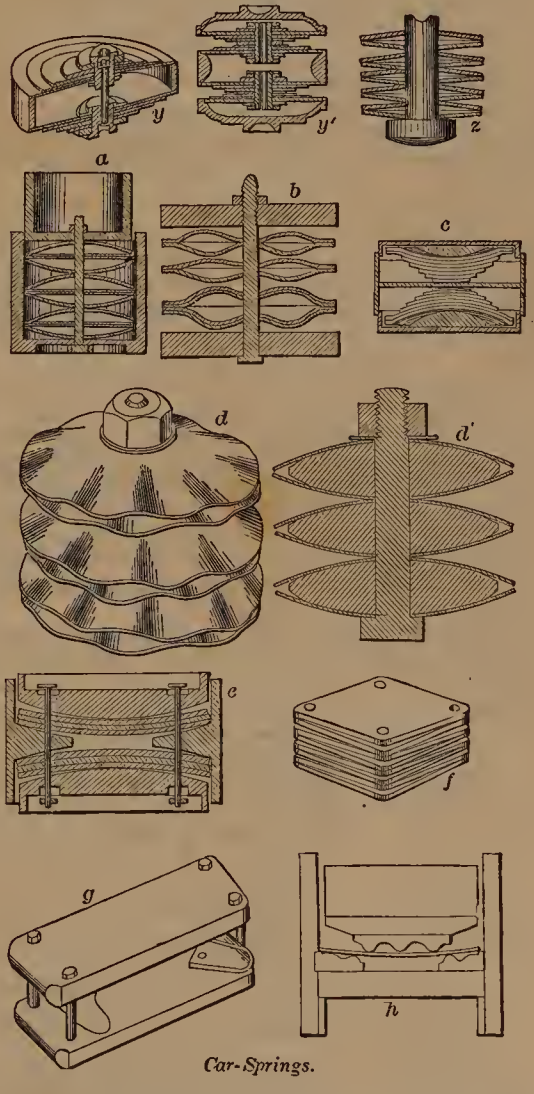
u is a congeries of spiral springs, one in the center, six in a hexagonal arrangement around the central one. Each set has a pair of spirals concentrically arranged, diversely coiled, and inclosed in its cylindrical sheath.

v consists of a steel plate folded and then bent into a spiral form around a mandrel.

w is a volute or helical spring, in which, differing from the spiral, the plate is wound on itself, and does not preserve the same diameter. The inner fold of the volute, being projected in the line of its axis, is made to sustain the load.

x is another helical spring, shown in elevation.

Fig. 1144.



Car-Springs.

In Fig. 1144, *y y'* are respectively a sectional view in isometrical projection and in simple elevation of a car-spring formed of a number of circular plates, of which those in each series are of graduated diame-

ters. In *y* the spring is a pair of such series; in *y'* two pairs of such are allied.

z has annular dish-shaped disks arranged in pairs and united by means of a rod passing through them.

a has plates formed of segments of spheres, and alternating with flat plates in groups; the whole placed in a box in which it is subjected to the pressure of a follower.

In *b*, the spring is composed of a pile of circular plates corrugated radially and arranged round a stem.

In *c*, the spring-plates are of gradually increasing lengths upward and downward from the middle diaphragm, and are inclosed in a case whose top and bottom plates are movable and have bearings on the ends of the longer and outer spring-plates. Rubber springs are interposed between the movable plates of the case and the spring-plates.

d has several pairs of concavo-convex radially corrugated plates; between the two plates of a pair is an interposed disk of vulcanized rubber. *d'* is a sectional view of the same.

e shows a box having several metallic plates, compressed from opposite directions and shortening between bearings as they are bent. This has the effect of making them less pliable as they recede before the weight.

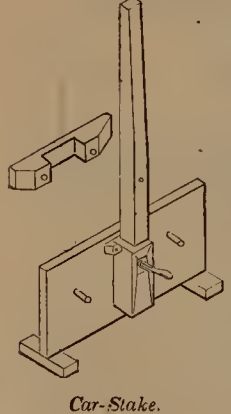
f has square or rectangular plates curved diagonally and fastened together at the corners, thus forming alternate pairs, which bear upon each other at the corners and diagonally through the centers; the bearing-points of the plates are changed by being lengthened and shortened when the spring vibrates.

g has square, rhombic, oval, or circular plates, bent bow-shaped, and interposed between the bolsters.

h has a plate or plates so disposed between the bearing-surfaces that with a light load it rests upon its ends and has its weight at the mid-length. When the weight increases, the load is transferred to points on the upper block nearer to the ends of the spring, and the rest of the latter is transferred to points nearer the mid-length, so as to shorten the portion of spring involved in the support.

Numerous modifications and applications of the foregoing examples might be shown. The trouble is, not that matter fails for more copious illustration, but that there is not room.

Fig. 1145.



Car-Stake.

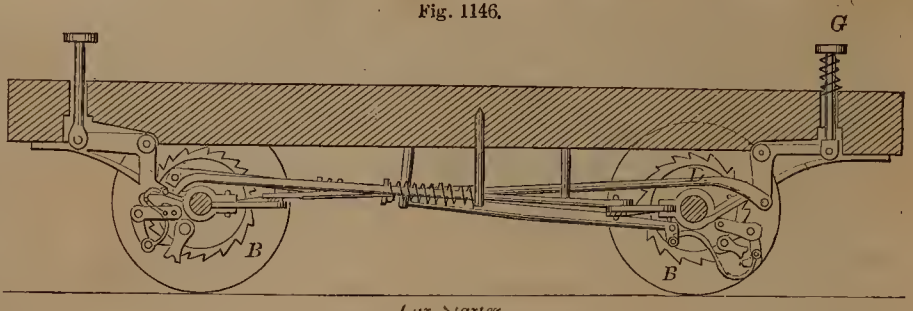
Car-stake. (*Railway.*) A standard set up in iron loops or sockets on the side of a platform-car, to hold a loose load, such as lumber or the like.

Car-start'er. (*Railway.*) A device to assist in starting a street-car from the dead-stop. These are of two kinds: —

1. Those in which the momentum of the car when the motion is arrested is made to accumulate a starting force.

In Fig. 1146 the pressure on the brake-treadle *G* causes a frictional contact between the driving-wheels *B* and the friction-wheels *D* on the same

Fig. 1146.



Car-Starter.

axle, which retards the motion of the drivers and condenses the spiral spring. When the pressure of the foot is withdrawn, the strength of the spring is permitted to actuate the ratchet on the wheel *B* and assist in giving the initial impulse, after which the parts assume their normal position, leaving the driving-wheels free. There are numerous modifications of the general idea.

2. A device in which the power of the team is temporarily applied to give a direct impulse upon the wheel, so as to start the latter rolling, and then transfer the power to the car as usual.

In Fig. 1147 this form of car-starter is shown. The draft-pole is connected to a lever and pawl, and the latter engages a ratchet-wheel as the axle.

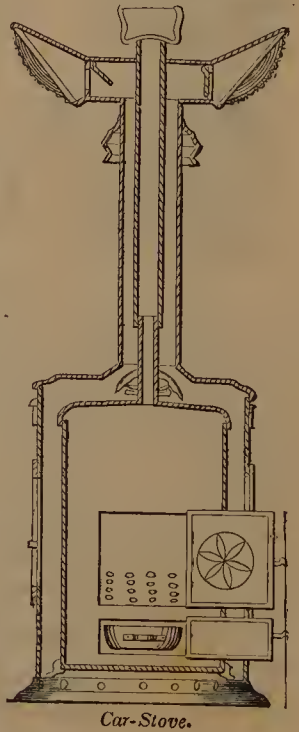
Fig. 1147.

Car-Starter.

After say a sixth of a revolution of the wheel, the pawl is disengaged and the usual draft condition of the car is resumed.

Car-stove. (*Railway.*) One specifically adapted for railway cars, having certain means for securing in place, prevention of scattering of fire in case of upsetting, or arrangements for the induction of outside air, and transmission of the warmed air to the interior of the car.

Fig. 1148.



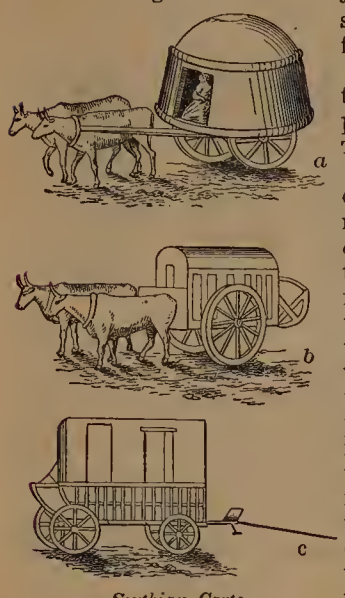
Car-Stove.

Stoves are fastened by sockets in the floor, anchor-bolts, and guys.

Fig. 1148 shows a stove which has an air-induction pipe surrounding the flue-pipe of the stove. Hoods above the car-top catch the air, which passes down and occupies the air-jacket around the stove, and from whence it is discharged into the car through registers.

Cart. Carts and wagons were used by the Scythians in the time of Herodotus (450 B. C.), and are mentioned a century later by Hippocra-

Fig. 1149.



Scythian Carts.

tes. The latter describes them as either four or six wheeled.

"Their wagons are the only houses they possess." — HERODOTUS, IV. 46.

These vehicles are drawn by oxen, as represented in the cut at *a b c*. The bodies of these carts are permanent or detachable; in the latter case constituting a tent-frame with a felt covering, which was readily placed on or off the running-gear of the vehicle. These are yet in use among some of the Tartar tribes, while others use carts like the gypsy habitations, unfortunately so common in England and the United States. See WAGON.

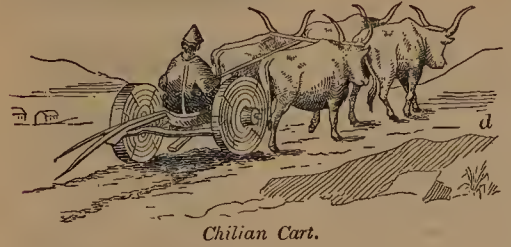
Hesiod's cart had low wheels, and was ten spans, about 7½ feet, in width.

"In default of camels, merchandise is generally transported through the deserts of Tartary by means of little two-wheeled carts. A few spars of rough timbers are all the material employed in their construction; and they are so light that a child can raise them with ease. The oxen which draw them have a small ring of iron passed through their nostrils, to which a cord is attached that links the ox to the cart which precedes him; thus all the carts are held together, and form an uninterrupted file." — *Huc's Travels in Tartary*, 1844–46.

As Strabo (19 B. C.) says: "The rest of the countries of Asia are principally inhabited by Scenites (*inhabitants of tents; Scythians*) and nomads (*hamaxœci, dwellers in wagons*), who dwell at a great distance."

Sometimes a wave breaks over the boundary, and the West sees an irruption of Huns, Turcs, or Tartars;

Fig. 1150.



Chilian Cart.

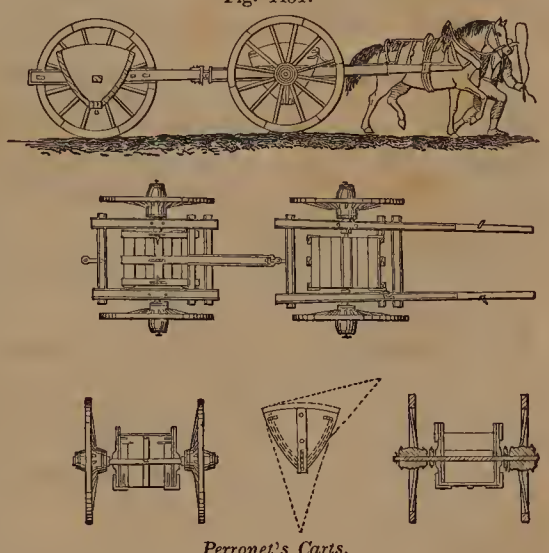
sometimes the head of the horde becomes a conqueror, as when Genghis the Khan conquered China, Persia, and Central Asia, A. D. 1206; or Timour (Tamerlane) conquered Persia, founded a dynasty in India 1402–1749, and broke the power of the Turcs in Asia Minor.

The Chilian cart *d* is a good illustration of the primitive vehicle on wheels. Its wheel consists of disks sawn or chopped from a log and bored for the axle. The tongue or pole is secured to the axle and forms the frame of the bed, somewhat like a city dray. Enlargements on the centers of the wheels outside form hubs, to prevent the wobbling of the wheels on the spindles. The hub and spindles, being of wood, and having a plentiful lack of grease, make music, — such as it is.

The French Engineer Perronet, who executed so many heavy public improvements during the last century (b. 1708; d. 1794), seems to have been capable of great projects, original devices, fanciful ornamentation, graceful designs, and effective details.

His ingenuity was manifested in the centering of his arches, coffer-dams, hydraulic and hoisting ma-

Fig. 1151.



Perronet's Carts.

chines, and in many other departments which we have had occasion to refer to in their proper places.

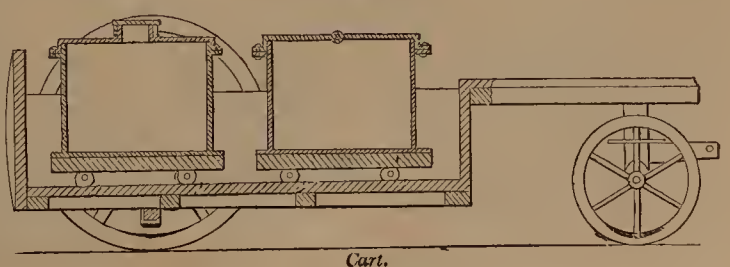
For removing the earth excavated in constructing the foundations of his numerous bridges, he used carts in pairs, coupled together.

Each cart had a bed capable of holding half a cubic yard of earth, and so suspended from the axle that a part of the contents was below the same, nearly balancing the load, so that the earth was easily dumped. In the rear of the forward cart-frame was a shackle, by which another cart was attached. Each cart could, therefore, be separately loaded and drawn into the regular track along which it was conveyed.

The shafts and frame were of timber, and the axle of iron. The wheels were large, and were placed far apart, to avoid upsetting. The rear carts had poles, the forward ones shafts.

The modern cart in England is adapted for many uses. With wide-spreading *raves* it is much used on the farms, especially in some parts of the country. The carts of the various trades, as coal-merchants, butchers, market-men, and others, cannot be more than referred to here. The cart Fig. 1152 is a low

Fig. 1152.



Cart.

body adapted for freight or express boxes, night-soil, or city drayage. The hind axle is bent, and the fore-end of the cart rests on a fore-carriage, constituting it a wagon, or very nearly so.

Dumping-carts for removing earth have a bed hinged to the axle, and adapted to tilt up and discharge the load when so desired.

Manure-carts are made in Britain specially adapted for distributing liquid or partially liquid manure either broadcast or in drills. They are fitted with pumps so as to be loaded from the tanks, and the distribution is made by perforated pipes or traveling-buckets.

Manure dumping-carts are also used, the barrel-shaped reservoir turning on its axis to discharge its contents.

A manure-cart is also sold in England, having a rotating spiked roller which distributes the barnyard manure from a cart or wagon as the vehicle passes over the ground.

Car'thoun. (*Ordnance.*) The old cannon-royal, carrying a 66-pound ball. It was 12 feet long, and had a caliber of 8½ inches.

Cart-lad'der. (*Vehicle.*) A rack thrown out at the head or tail of a cart, to increase its carrying capacity. Called *raves* in some places.

Car'ton. Pasteboard for paper-boxes.

Car'ton-pi-erre'. 1. A species of papier-maché, imitating stone or bronze sculpture. It is composed of paper-pulp mixed with whiting and glue. This is pressed into plaster piece-molds, backed with paper, and when sufficiently set, removed to a drying-room to harden. It is used for picture-frames, statuettes, and architectural ornaments.

2. Very hard pasteboard.

Car-toon'. A sketch in chalk made on rough paper, to be transferred by pricking through on to a freshly plastered wall to be painted in fresco. Among the most celebrated are those of Raffaelle.

Car-touch'. 1. (*Architecture.*) A modillion or console supporting the eave of a house.

2. (*Fire-arms.*) *a.* A cartridge; a roll of paper containing a charge.

b. A case filled with shot to be fired from a cannon. (Obsolete.)

Car-touch'-box. A portable case in which cartridges are carried. A cartridge-box. See ACCOUTERMENTS.

Car'tridge. A "round" of ammunition, including the ball with the sabot, if any, and its projecting charge, enveloped in a single case.

This is a modern institution, it having been originally customary to employ loose powder and ball.

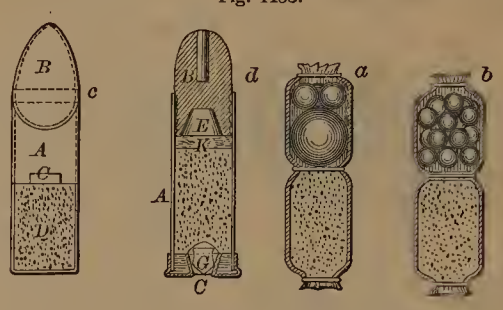
Then followed a cartridge containing a measured quantity of powder, the bullets being carried separately in a bag. The end of the paper cylinder was bitten off and the paper used as a wad. Gustavus Adolphus (killed at Lutzen, 1632) is said to have been the first to have made up the cartridge with a measured quantity of powder and a ball fastened thereto.

Sir James Turner, in the time of Charles II. of England, speaks of cartridges employed by horsemen, carried in a "patron" which answered to the modern cartridge-box. After this time it appears that cartridges were carried in cases suspended from *bandoliers*, equivalent to the more modern bayonet scabbard-belt.

Soon afterward the great improvement — the cartridge-box — was adopted, which still, under various modifications, continues in use. See ACCOUTERMENTS.

Plain, round ball, and buck and ball cartridges

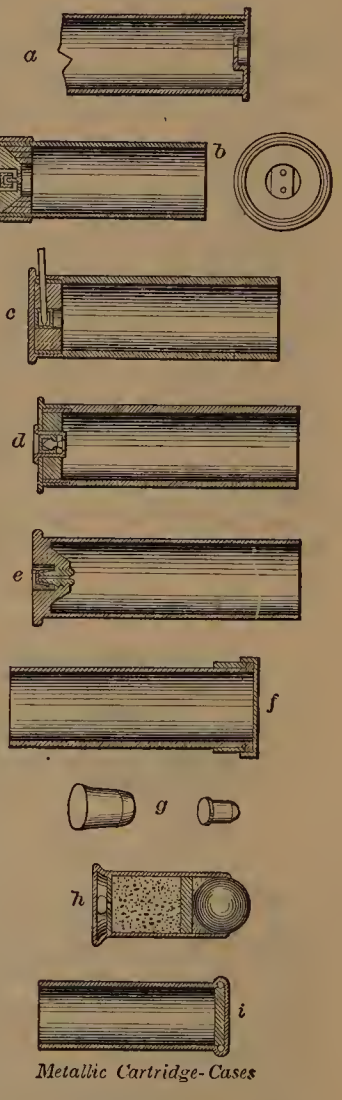
Fig. 1153.



Cartridges.

are now practically obsolete. These were formed of a paper cylinder, which was partially filled with powder and choked near its mid-length by twine, the powder occupying one end and the ball the other. Other substances than paper, as animal intestines prepared in a peculiar way, were sometimes employed. Colt covered his cartridges with tin-foil, and afterwards a paper saturated with nitrate of potassa was introduced. This might be placed in the gun as it was, the covering facilitating, rather than retarding, the ignition of the powder. In Fig. 1153, *a* is a *buck and ball* cartridge, *b* one having buckshot only, *c* the Prussian needle-gun cartridge (see FIREARM). In this the bullet *B* has a sabot *A*, separating it from the powder *D*, and having at its base a cavity *C*, for the reception of fulminate. The case of this cartridge is made of paper.

Fig. 1154.



Metallic Cartridge-Cases

d, Snider's, for the muzzle-loading Enfield rifle converted into breech-loading (see FIREARM), is made up of a sheet-brass cylinder *A*, into which is inserted the bullet *B*, having at its base a recess *E*, which contains a plug of clay. Back of this is the powder-chamber, having at its base a sabot *G*, into a cavity of which fulminate is inserted and exploded through the action of the firing-plunger on a cap *C*.

It may be remarked that the American process of drawing out the blanks for metallic cartridge-cases into tubes is now generally adopted into the European services.

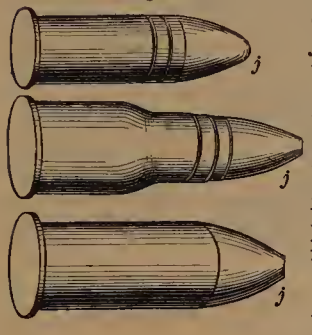
This style of cartridges is divided into two classes

— *rim* fire and *center* fire, — the first having the fulminate arranged within a cavity around the interior of the flange, and the latter having it arranged at the center of the head or base of the cartridge. Each kind requires the hammer or firing-pin of the gun to be specially arranged, in order to strike the cartridge at the proper point, though cartridges have been devised in the United States to be both *rim* and *center* fire, and guns have also been made to fire either or both kinds of cartridges.

The idea of using sheet metal for this purpose seems to have originated with the French.

In 1826, Cazalat patented a cartridge of this kind (*a*, Fig. 1154), having a receptacle with a covering patch of water-proof paper for fulminate at its base. A hole in the bottom of the cup admitted fire to the charge. This appears to have been in advance of the age, being drawn from a single piece of copper, and being *center-fire*. *b* and *c* represent two forms of the Lefaucheux cartridge, — one of the earliest of this kind. In *b*, the cap is secured to an anvil-block; in *c*, a plunger, struck by the hammer, explodes a fulminate placed in a chamber at the base.

Fig. 1155.

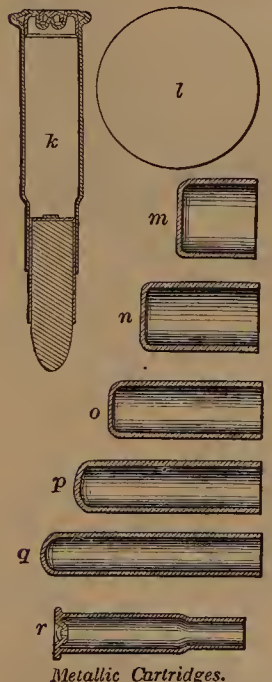


d, *e*, show modifications of this, the anvil and cap principle, in which the pin is dispensed with.

f. One of the earliest-known cartridges is that of Roberts, of Paris, 1834, in which an annulus was formed at the base to contain fulminate.

g is the Flobert cartridge, in which is a ball with a charge of fulminate at the base, which does the duty at once of priming and propelling, adapted for target-practice at short ranges.

h, *i*, Smith and Wesson patents, 1854, 1860. In the first of these the fulminate was contained in a capsule at the base, and in the latter in an annulus within the flange surrounding the base of the cartridge, and secured in place by a pasteboard disk.



Metallic Cartridges.

j, *j*, *j*, show some other forms of metallic cartridge as now commonly used.

k is the Berdan cartridge; this has an exterior central recess, a bottom to receive the cap, which is exploded upon an anvil turned up on an interior metallic lining. The case is adapted to fit a chamber larger in diameter than the bore of the barrel.

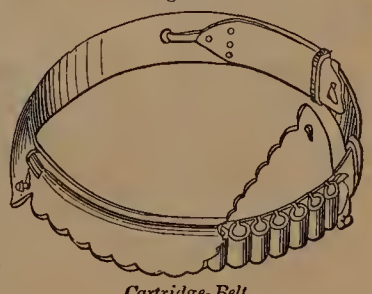
The mode now generally adopted for forming metallic cartridges is to punch the blank out from a sheet of brass, and to draw it between successive rolls and punches until it assumes the required shape. The shape which the cartridge-case assumes during the different stages of the process is shown in the figures *l* to *r*.

Cannon-cartridges for 6 and 12 pounder smooth-bored field-guns, the former of which may now be considered obsolete, have the powder-charge, contained in a woolen or silken bag, and the projectile united together by twine. For larger smooth-bored and all rifled guns, the powder is put up in a separate bag, still, however, retaining the name of cartridge.

Car'tridge-bag. (*Ordnance.*) A flannel bag holding a charge of powder for a cannon.

Car'tridge-belt. A belt for the waist or to go over the shoulder, having pockets for fixed ammunition.

Fig. 1156.

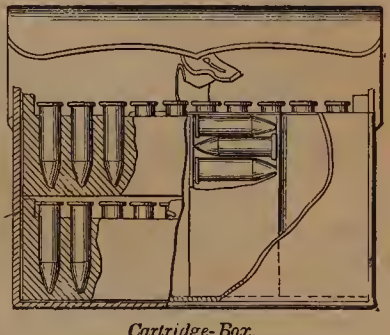


Cartridge-Belt.

Car'tridge-box. Gustavus Adolphus (killed at Lutzen, 1632) reduced the weight of the musket from fifteen pounds to ten. He also introduced the paper cartridge, which at first only contained the powder, the bullets being kept in a bag.

Cartridge-boxes at first were very small, but the Germans soon enlarged them so as to contain forty rounds. Nevertheless, for a long time after, priming was done with a powder-horn, until at length the plan of using some of the powder of the cartridge was hit upon.

Fig. 1157.

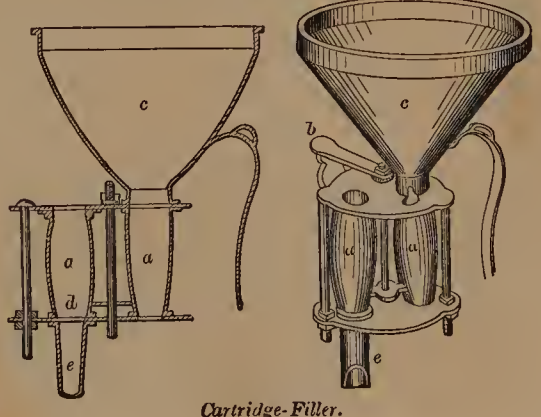


Cartridge-Box.

Cartridge-boxes are made to contain such number of rounds as may suit the service. Some are specially adapted to certain kinds of ammunition, as the Spencer, for instance. (See ACCOUTERMENTS.) Some are designed to give each cartridge a pocket, to prevent their jumbling about. One of them is circular, having radial pockets; another has flaps and loops, like a homœopathic dispensary.

Car'tridge Fill'er. A device for charging cartridge-

Fig. 1158.



Cartridge-Filler.

cases with the proper quantity of powder. In that shown, the two filling-tubes *a a* are partially rotated by the lever *b*, so as to bring each of them alternately under the funnel *c*, and over the discharge-aperture *d*; while one is being filled, the other is discharging its contents into a cartridge-case through the pipe *e*.

Car'tridge-pa'per. A strong paper of which cartridges are made. It is of various sizes and thicknesses, according to the kind of cartridge to be made, ranging from a quality similar to bank-note paper, employed for small-arm cartridges, to that used for cannon cartridges, which is about the thickness of thin pasteboard, but rougher and more flexible. The latter is, however, now seldom or never used. The different qualities are in the United States service numbered from 1 to 6, the latter being the coarsest and thickest.

Car'tridge-prim'ing Ma-chine'. A machine by which the fulminate is placed in the copper-cap-sule of the metallic cartridge. The fulminate is differently disposed for center-fire and for rim-fire cartridges; in the latter the cartridge-case is rotated on its longitudinal axis, to dispose by the centrifugal action the fulminate at and about the flange.

Car'tridge-re-tract'or. That part of a breech-loading fire-arm which catches the empty cartridge-capsule by its flange, and draws it rearwardly from the bore of the gun.

Car'tridge-wire. 1. (*Blasting.*) The priming-wire whereby the cartridge is connected to the conducting-wire of the voltaic battery.

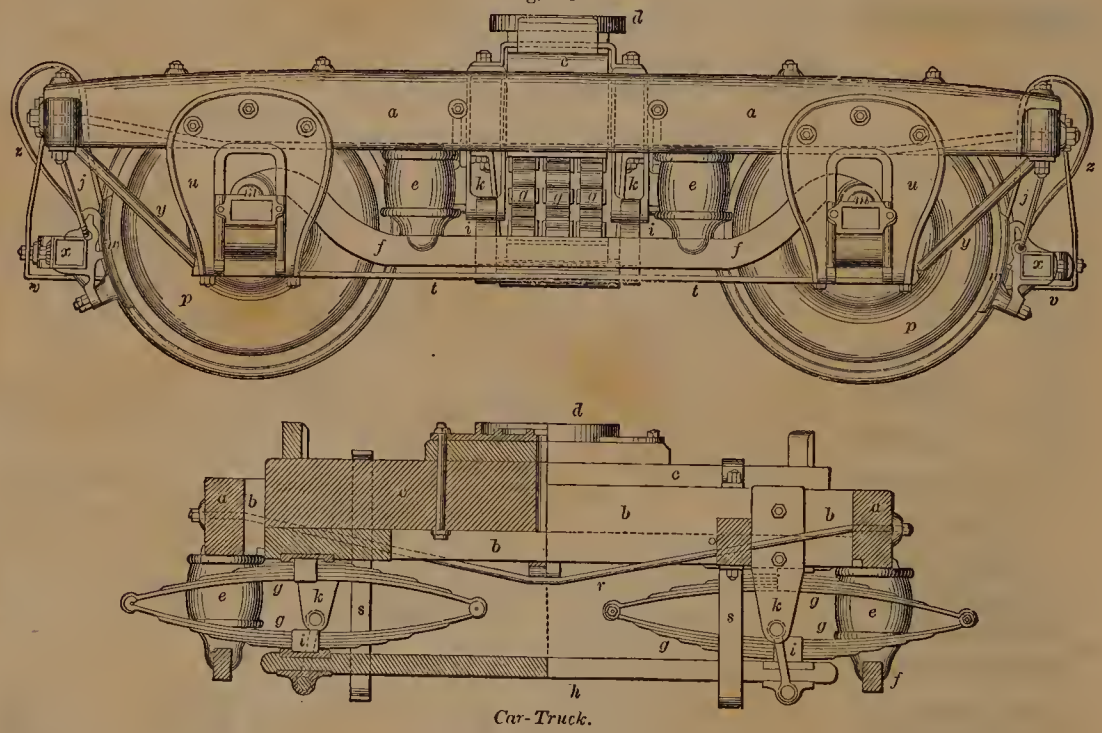
2. (*Ordnance.*) The needle whereby the cartridge-envelope is pierced, in order that the priming may connect with the powder of the cartridge.

Car-truck. (*Railway.*) A wheeled carriage beneath a railway car. The first railway cars had wheels on axles, arranged similarly to those of a wagon. It was afterwards found more convenient and efficient to shrink the wheels on to the axle, so that they might revolve together; but even then the pedestals of the axle-boxes were attached to the bed of the car, as is yet the case generally in Europe.

The American practice has long been to support the car on two four-wheeled trucks, and latterly six-wheeled trucks have been used under a superior class of passenger-cars. The capacity, duty, and endurance of car-wheels is alluded to under CAR-WHEEL; but it may be here stated that the addition of the two wheels to the truck increases by one half the number of parts involved in the duty of supporting the load.

There are many kinds of trucks, but they agree in the feature of swiveling beneath the car-bed as the car rounds a curve, and in having a certain freedom of motion which is not as necessarily transmitted to the car as it would be, on a truck of a given quality, were the axle-boxes on pedestals attached to the car-bed directly.

Fig. 1159.



Car-Truck.

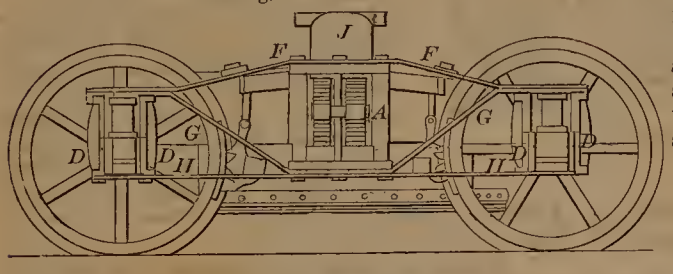
In the illustration, *a a* are the longitudinal timbers of the frame of a passenger-car truck, such as may be found on some of the best of our railways. *b* is one of the transverse timbers of the frame. Within this frame is suspended the *swinging-bolster c*, having at its mid-length the *center-casting d*, which forms the bushing for the king-bolt, and also what may be called the "fifth wheel," on which the car-end oscillates as it swerves, rolls, and pitches. The car-frame *a b*, while supporting the car-end through the medium of the swinging-bolster as described, is itself supported through the medium of the *gum-springs c e*, a pair on each side of the truck upon the equalizing bar *f*, whose ends rest upon the upper boxes of the axle-bearing. This is the account in short, but there are several other parts involved, as will appear by tracing the sequence of the impositions from the car to the rail.

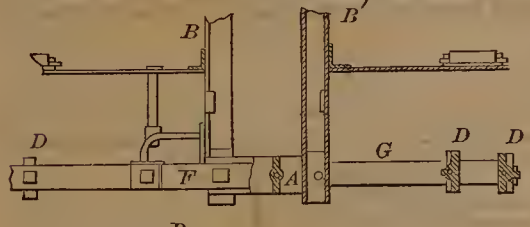
The car-end rests upon the *center-casting d*, which is in a position mid-length of the *swinging-bolster c*; this rests upon the upper members of the *elliptic springs g g*, which are founded upon the *suspension-bar h*, which connects the two points of imposition of the springs *g g*, making each a brace for the other. The suspension-bar *h* is suspended by *yokes i i*, from *hangers k k*, which are bolted to the *transverse-tim-*

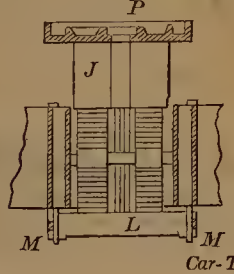
bers b b of the truck-*frame*, of which they form a part. The *longitudinal timbers a a* of the frame, on each side of the truck, rest upon the *gum-springs e e*, and these upon the *equalizing-bar f*, whose ends are upon the upper boxes *m m* of the axle, outside of the wheel *p*. For the detail of this portion see AXLE-BOX.

The upper illustration of Fig. 1159 is a side elevation, and the lower one is a section, the respective halves of the view being taken on different section-lines. *r* is a tension-bar or *tie* to strengthen the frame; *s s* are *safety-stirrups*, to catch the *suspension-bar h*, if anything should give way; *t* is a *brace-rod* between the two *pedestals u u*, in which the axle-box works up and down as the gum-springs contract or expand. *w w* are the *brake-shoes*, on the end of the *brake-bars x x*, which are moved by a rod and lever arrangement. (See CAR-BRAKE.) *y y* are

Fig. 1160.







Car-Truck.

diagonal-brace rods for the *pedestals*. *z z* are the *relieving-springs* which throw the shoes away from the wheel when the tension on the brake-mechanism is withdrawn. *v v* are the *safety-stirrups*, to catch the brake-bars if the *swing-bars j j* should give way.

Thus it will be seen that two sets of springs intervene between the car and the rail; the car-end rests upon a swinging-bolster which has elliptical springs beneath it, and these are suspended from a frame which itself rests upon gum-springs on the equalizing-bar which rests on the axle-boxes.

There are many modifications of the general form shown in Fig. 1159, but the feature of a spring-supported bolster "swinging" within a frame-spring supported on the wheel-axles is generally maintained.

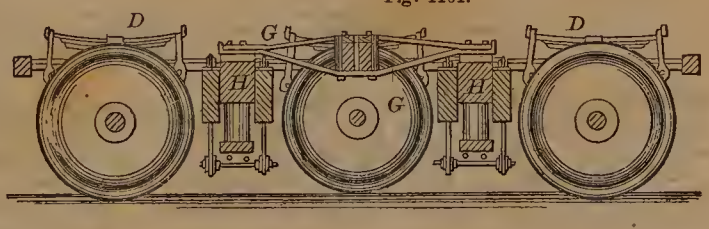
In Fig. 1160 is shown one modification, in which the sides of the frame are iron trusses, each composed of a plate *F F*, tie *H H*, and braces *G G*, having guides *D D*, which act as pedestals in which the axle-boxes ascend and descend, as the springs give way and recover themselves. Within the side trusses are bolted the ends of the transverse frames *A B B′*. *P* is the center-casting, which rests on a post *J*, and this upon the elliptic springs in the frame *A B*, as shown in the upper portion of Fig. 1160, and on an enlarged scale in the lower left-hand corner of the same figure. The springs rest on the bar *L*, and the weight is transferred by hangers *M M* to the main frame and trusses, which, as has been said, rest on the axle-boxes. The mechanism for operating the brake-shoes need not be particularly described.

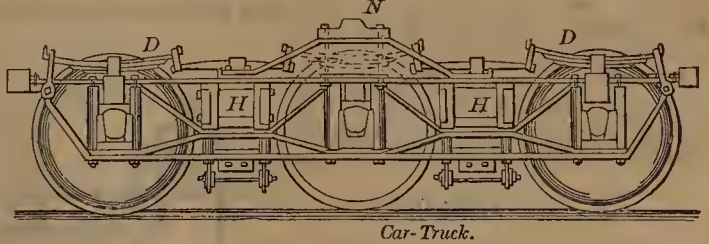
Fig. 1161 represents a vertical longitudinal section and side elevation of a six-wheeled truck. This has a rigid frame, maintaining the wheels in the same line at all times, but allowing them to run over curves in the track by having the flange removed from the middle wheel of each trio. The truck is so supported that the weight is equally distributed upon all the wheels, by resting it upon a support over, but not upon, the middle axle, said support being sustained by springs placed on each side of and equidistant from the middle axle, and the whole weight being transferred to the axles through a rigid frame.

The weight of the car-end, in this case as in the previous examples, is taken upon the central beam, and is then transferred to swinging-bolsters *H H*, which rest on gum-springs, and these upon transverse bars, which are suspended by stirrups from the main frame, which, in the example before us, is an iron truss-frame. The truss-frame is suspended from elliptic springs, which rest eventually upon the axle-boxes. *N* is a side-bearing block, to restrain undue lateral oscillation of the car.

Fig. 1162 shows a portion of an eight-wheeled truck which is composed of two independent four-wheeled trucks connected together by means of a

Fig. 1161.

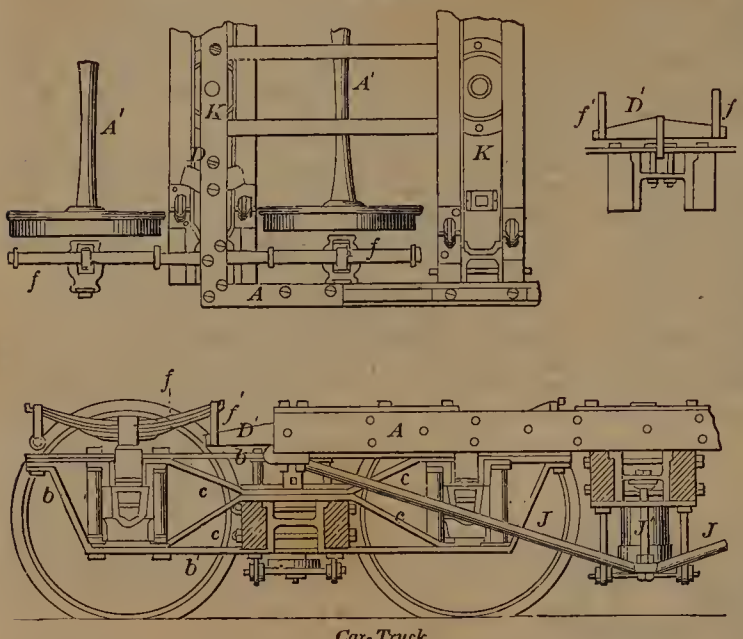




Car-Truck.

platform *A*, which is supported upon and connected by pivots to laterally swinging bolsters *D* on each sub-truck (one only shown). The end of the coach is supported on the middle transverse swinging-bolster *K* of the frame *A*, and the swinging-bolsters in the middle of the sub-trucks abut upon rubber blocks at their ends, and rest upon rubber blocks whose supports are swung from the sub-truck frames *b b′ c*, and by them transferred to the elliptic side-springs *f*, which rest upon saddles over the axle-boxes. *J J* are truss-rods which strengthen the main frame.

Fig. 1162.



Car-Truck.

With lighter cars, such as those of street railways, this combination of great strength and elasticity is not required.

In Fig. 1163 is shown a car whose bed is supported, on each side, at four points, by means of four pedestals, as many rods, and two semi-elliptic springs.

Car-truck Frame. The strong wooden frame which rests upon the wheels by intermediate springs and parts, and which by other intermediate springs supports the swinging-bolster upon which the car directly rests. See CAR-TRUCK.

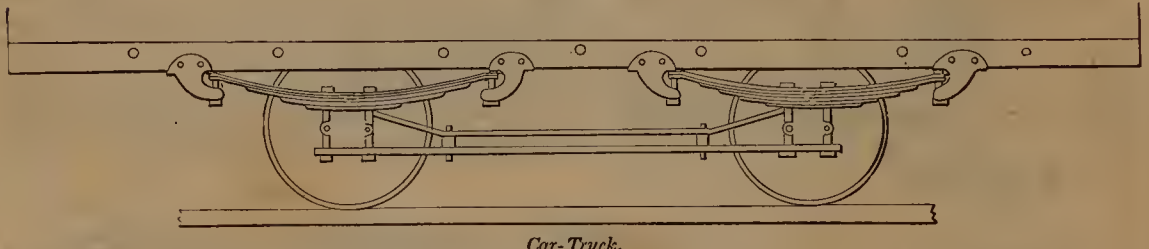
Car-truss. That combination of sills, plates, braces, and tie-rods which forms the skeleton of the car, and upon which, as a frame, the floor, sides, roof, etc., are fastened.

Cart-sad'dle. The saddle upon which rests the chain which goes over the horse's back, and whereby the shafts of a cart are supported.

Car'vel-built. (*Shipbuilding.*) *a.* A mode of building in which the timbers are cut out of the solid, as in ships and the larger description of boats, such as launches, long-boats, and barges. (See BOAT.) The planks make flush seams instead of lapping, as in the *clincher-built.* The seams are calked. The frame of a carvel-built boat generally consists of a floor and two futtocks.

b. A mode of joining the plates of iron vessels, in which the edges of the plates are brought flush to-

Fig. 1163.



Car-Truck.

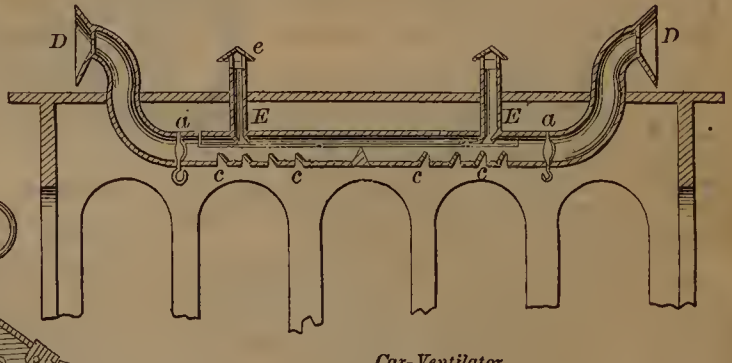
gether and riveted to a lap or *welt* in the rear. In *clincher-built* iron vessels the plates overlap, and are secured together by one longitudinal row of rivets.

Car'vel-joint. A *flush* joint; said of ship's timbers or plates, in contradistinction to *clincher.* See CARVEL-BUILT.

Car-ven'ti-la'tor. (*Railway.*) A device for bringing fresh air into a car and removing noxious air therefrom. Fig. 1165 is one form, in which a cowl or hood *D* on the roof catches the air, which is filtered through a gauze screen and led down through the roof of the car. Crescent-shaped openings *c* deflect the air into the car, and other openings lead up the foul air, which is discharged through the vertical pipes *E.* The mouths of the dampers *D D* are presented fore and aft respectively, and one of the dampers *a* is moved, to close the pipe, according to the direction in which the car is moving.

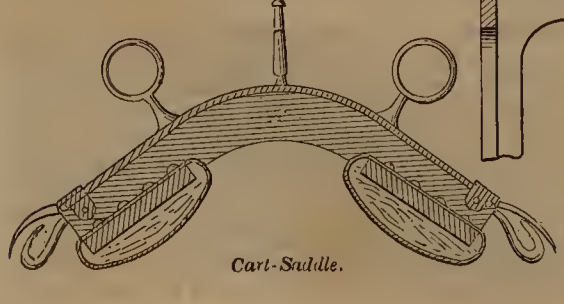
The device shown in Fig. 1166 is designed to open or close simultaneously all the alternating shutters

Fig. 1165.



Car-Ventilator.

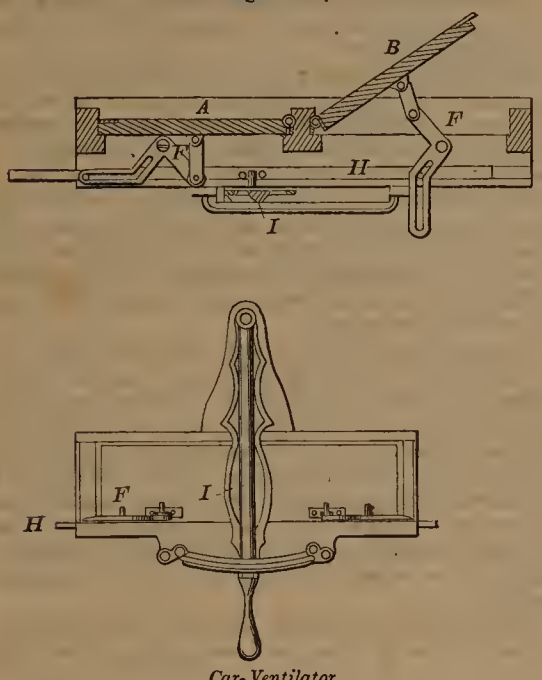
Fig. 1164.



Cart-Saddle.

on one side of the turret of "monitor cars." All the shutters may be closed at once, yet it is the

Fig. 1166.



Car-Ventilator.

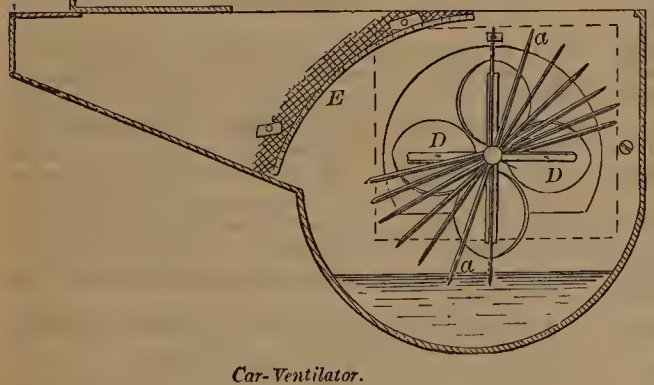
practice to have one half of the shutters open while the carriage is moving in one direction, and to reverse the position of the shutters — i. e. open those which are closed and close the open ones — when the carriage moves in the opposite direction.

The mechanism for operating the shutters consists of the slide-bar *H* and its operative lever *I*, and a series of slotted and bent levers *F*, and their connecting links. The slide-bar *H* runs the length of the car-turret. In the upper figure, which is a horizontal section, the rear shutter *B* is shown open, and *A* closed. In the lower figure, which is in elevation, the lever is clearly shown by which the series of ventilating-shutters are operated.

In Fig. 1167 is shown an adjunct, consisting of a means of removing the dust from the air entering the induction-openings *D*.

The paddles *a* on the rotating shaft dip into a water-bath at the bottom of the ventilator when

Fig. 1167.



Car-Ventilator.

actuated by the draft on the fans. The dust in the entering air is collected in the water. The air passes through a screen *E* before admittance to the car. See AIR-FILTER.

Carv'er. A large, pointed knife for cutting up meat and poultry. See CARVING-KNIFE.

Carv'ing. The art of cutting wood, etc., to ornamental forms by means of chisels, gravers, scorpers, etc. With metals, it becomes *chasing;* with plastic material, *molding.*

It is a very ancient art, having been employed in Assyria, Babylon, Persepolis, Egypt, and Greece upon chariots, furniture, weapons, and many other objects.

It was about 1491 B. C. that Bezaleel, of the tribe of Judah, was specially selected for his skill as a workman in gold, silver, brass, gem cutting and setting, and *carving in wood*, and was commissioned to execute the work upon the Tabernacle and its furniture. Aholiab, of the tribe of Dan, was his first assistant, and he had other coadjutors not mentioned by name. The Egyptians, among whom Moses, Bezaleel, and others, had been educated, were justly renowned for their skill and taste in carving, as is abundantly shown by their chairs, biers, couches, arms, chariots, musical instruments, and other articles cited under their respective heads in this work. To mention one specially, their chairs left little to be desired or attempted either in comfort, beauty, or upholstering. See CHAIR.

The ornamentation of the Temple of Solomon, and its furniture, about 1005 B. C., called for the skill of a workman who was of a mixed Tyrian and Israelitish descent. His skill in carving and casting was derived from his father, who followed the business of a pattern-maker and bronze-founder in Tyre.

The ornamentation of the day consisted of copies of natural objects, formally associated, resembling that which, frozen into conventional forms, gave a severe grace to the Grecian architecture. The capitals of the bronze columns erected by Hiram Abiff were ornamented by "nets of checker work, and wreaths of chain works," lilies and pomegranates being strung upon the pillars and their capitals.

"Hiram made the lavers, and the shovels, and the basins. The two pillars, and the bowls of the chapiters on the top of the two pillars, and the two networks to cover the two bowls of the two chapiters, — and four hundred pomegranates for the two networks, even two rows of pomegranates for one network, — and the ten bases, and ten lavers on the bases; and one sea, and twelve oxen under the sea; — all these vessels were of bright brass" (bronze), and were cast in the plain of Jordan, "in the clay ground between Succoth and Zeredathah."

These utensils, together with the great sea of bronze which held 2,000 baths, required great skill in carving and casting, and are deemed very remarkable for the time at which they were executed. The surprise expressed arises from our own vanity and depreciation of the skill of those who preceded us a few thousands of years. The bath, as estimated by Josephus, was equal to $8\frac{2}{3}$ gallons (8.6696); according to the Rabbinical writers, $4\frac{1}{2}$ gallons nearly (4.4286); Smith estimates it at $7\frac{1}{2}$ gallons. Taking the lowest estimate, the brazen (bronze) sea of the temple court held over 9,000 gallons. The Chaldees broke it in pieces to remove it to Babylon, about 590 B. C. They estimated it only as so much metal; they "carried the brass [bronze] of them to Babylon."

This was a large vessel, and may well be believed of the time when works of art were estimated by their colossal proportions. The stones of Egypt and Baalbec are yet unrivalled in modern times. See STONE-CUTTING.

The doors of Solomon's Temple were of olive-tree wood, and on them were carved "cherubim and

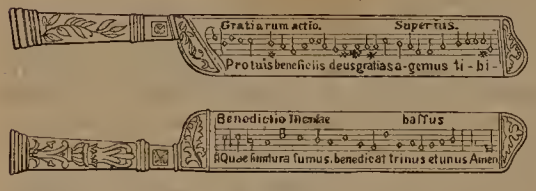
palm-trees and open flowers." The carving was overlaid with gold. Other doors were of fir, similarly carved and plated.

The doors of the temple of the Indian idol Somnauth were of sandal-wood elaborately carved. They were taken by Mahmoud of Ghizni, A. D. 1024, and were made the entrance-doors to his tomb in Afghanistan. They were retaken by the British in 1842, and the Governor-General, after a pæan in their praise worthy of a *fakir*, ordered them to be restored "with all honor" to the obscene idol, "avenging the insult of 800 years." Good sense stepped in and countermanded the absurd order. See DOOR.

Carv'ing-chis'el. A chisel having an oblique edge and a basil on both sides. A *skew* chisel.

Carv'ing-knife. A large-sized knife used for cutting meat at table. It is usually handsomely mounted. The carving-knives of two centuries since were a part of the state service of the refectory.

Fig. 1168.


Gratiarum actio. Supertus.
Protuisbeneficiis deusgratiasa-gemus ti-bi-
Benedicito Mensæ bastus
Quæ sumtura sumus. benedicat trinus et unus Amen

Grace-Knives.

Those represented had the grace before meat and that after meat, with the music of the intonation.

Achilles carved for his visitors, and each was expected to eat his mess without grumbling. Joseph sent to Benjamin a larger mess than to either of the other brothers.

As to behavior at table, we learn from Plutarch and others that paring the nails at table was the height of vulgarity; speaking loud, spitting and coughing, were unregarded trifles. As the guests had no forks, they wiped their greasy fingers on soft bread, which they then threw to the dogs. "The dogs eat of the crumbs." Napkins came into fashion later.

In after ages each man grasped the joint and carved for himself. (See CASE-KNIFE.) Table-forks are a much later thought; they came from Italy to England in the time of the Stuarts. See FORK.

Bread, meat, and beer formed the usual feed of our ancestors in England down to and during the reign of Elizabeth, and the people busied themselves curiously in the modes of carving, inventing a whole category of technicals. Juliana Berners, lady prioress of the nunnery of Sopewell in the fifteenth century, the reputed author of the "Book of St. Albans," gives the following as the terms applied to carving the respective animals:—

"A dere was broken, a gose reryd, chekyn frusshed, a cony unlaced, a crane dysplayed, a curlewe unioynted, a quayle wyngged, a swanne lyfte, a lambe sholdered, a heron dysmembryd, a peacock dysfygured, a samon ehynyd, a hadoke syndyd, a sole loynyd, and a breme splayed."

Carv'ing-ma-chine'. One for carving wood, or roughing it out preparatory to the chisels, gouges, and scorpers of the carver.

As early as 1800, a Mr. Watt, of London, built a machine that carved medallions and figures in ivory and ebony, producing some very handsome work with great rapidity; in 1814 and 1815, Mr. John Isaac Hawkins, of the same city, produced a similar machine for the same purposes; in 1828, a Mr. Cheverton built a machine for similar purposes, the operations of which attracted considerable attention throughout Europe.

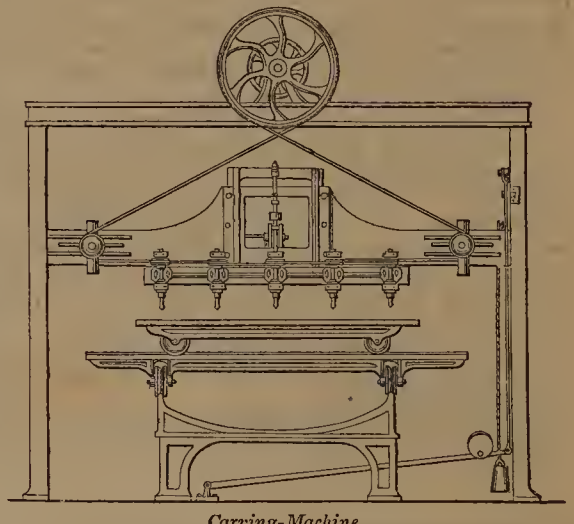
BRAITHWAITE'S carving process (English), November, 1840. This process is not dependent upon cutting-tools, but the wood is burned away, or rather converted into charcoal. The wood is steeped in water for about two hours, and the cast-iron die, or mold containing the device, is heated to redness or sometimes to a white heat, and applied against the wood, either by a handle, as a branding-iron, by a lever, or by a screw-press, according to circumstances.

The molds are cast from plaster casts of the original models or carvings.

The saturation of the wood with water prevents its ignition. It gives off volumes of smoke, but no flame, the wood being charred. After a short time, the iron is returned to the furnace to be reheated, the blackened wood is well rubbed with a hard brush to remove the charcoal-powder, which, being a bad conductor of heat, saves the wood from material discoloration. Before the reapplication of the iron the wood is again soaked in water, but for a shorter time, as the wood now absorbs water with greater facility.

The rotation of burning, brushing, and wetting is repeated 10 or 20 times, or more, until, in fact, the

Fig. 1169.



Carving-Machine.

wood fills every cavity in the mold, the process being materially influenced by the character and condition of the wood itself, and the degrees in which the moisture and heat are applied. The water so far checks the destruction of the wood, or even its change of any kind, that the burned surface, simply cleansed by brushing, is often employed, as it may be left either of a very pale or deep brown, according to the tone of color required, so as to match old carvings of any age; or a little scraping removes the discolored surface.

Perforated carvings are burned upon thick blocks of wood and cut off with a circular saw.

In the machine (Fig. 1169) several copies are carved at once, the pattern being placed midway between them. The model and the wood for the copies are placed, say, 8 or 10 inches apart, on a rectilinear slide, free to move in one direction upon a carriage, which is free to move in a direction at right angles to the former. This forms what is called the *floating-table*, as by a combination of the two motions any direction may be attained. The two movements of the table

are under the control of the two hands of the workman while he controls a third slide with his foot. The third slide, which is vertical to the other two, carries in the center a tracer of globular form, and also, at 8 or 10 inches on the right and left of the tracer, cutters of the same globular form, which latter are set to make about 6,000 revolutions per minute. The third slide, which, together with the tracer and side-cutters, forms one entire mass, descends upon the wood with a moderate pressure, that sends the side-cutters into the two blocks of wood until the central tracer rests in contact with the model; the cutting then ceases, and the slide is raised from the work by the treadle.

In this manner, by a multitude of vertical incisions at different parts, the whole surface of the blocks beneath the cutter is removed to a depth corresponding to the exact shape of the model. For expedition, a horizontal motion is imparted to the bed-plate moving the wood against the cutters; the depth at any point being determined by the contact of the tracer with the model. The necessary conditions are, that the tracer and cutters be alike in form and size, and that the distance between them, and also the distance between the model and copies, whether 8 or 10 inches, or any other measure, be preserved throughout the one process.

The above case, in which the work lies horizontally, is that most usually required; but when the work has to be carved on all three sides, — as, for example, in brackets or consoles projecting from a wall, — although the arrangement of the central tracer and the cutters parallel therewith, partaking of a vertical motion in common, be preserved, the model and copies are all three adjusted so as at one time all to lie on their backs, at other times on their right and left sides, with the progress of the work. Sometimes this change is effected simultaneously by mounting them on platforms that are situated on fixed parallel and equidistant axes, and shifting all three at one movement, by a simple arrangement derived from the ordinary parallel rule with radius-bars.

In case of figures carved in the round, or on every side, the central model and two copies are built above one wide bar, upon three circulating pedestals or turn-plates, with graduations or detents, by which the three objects may be alike twisted round to face any point of the compass; and as the wide bar upon which the three circulating pedestals are built has a tilting motion by which the three pedestals may be all alike placed either horizontally, or inclined to the right or left, in any degree, until nearly vertical, it is clear that these two directions of motion constitute universal joints, and enable any and every similar part, of all three objects, to be presented to the tracer and cutters respectively.

The machines are used for wood, soft stone, marble, and alabaster.

The Blanchard machine for turning irregular forms has been used for turning lasts, spokes, axe-handles, gun-stocks, busts, etc., and in some of its applications may be termed a carving-machine. It differs from those just described in the circumstance that the object to be turned is rotated, constituting the machine a true *lathe*, while the revolving cutter is drawn out or in by means of a revolving pattern. The variations of detail will be mentioned under LATHE (which see).

Carv'ing-ta'ble. A table heated with hot water, in which are depressions forming pans to hold joints of meat.

Car-wheel. One adapted for the uses of cars, or the trucks of railway cars.

They were originally like those in ordinary use, and were guided by *flanges on the rails*, as in the case of the Sheffield Colliery Railroad, 1767. At this time the rails were of cast-iron.

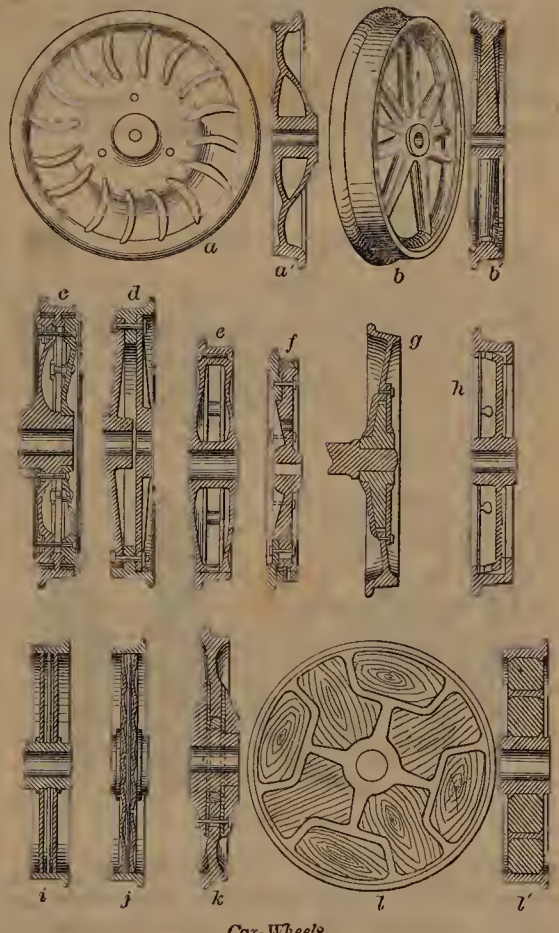
In 1789, car-wheels were made with flanges, to run on the *edge-rail*, which was first made of cast-iron and used at Loughborough, England.

In Stephenson and Losh's patent, 1816, car-wheels were made with wrought-iron spokes, the hub and rim being cast on to them. A wrought-iron tire was shrunk on to the rim, and secured in its seat by a dovetailed depression.

In Fig. 1170 are shown a few examples of the numerous inventions of this class.

a a' represent the famous Washburn wheel so familiar to us all. It has an arch at the central

Fig. 1170.



Car-Wheels.

portion adjacent to the hub, and the apex of the arch is connected by a curved web with the rim, the junction of the web and rim being strengthened by ribs or brackets. *a* is a side elevation, and *a'* a diametric section.

b b' are perspective and sectional views of a wheel whose hub is connected by spokes with the rim. Such was Stephenson and Losh's, already mentioned; indeed, this is quite an antiquated form.

c is one of the Woodbury wheels, which has a compressed annular elastic packing between the cylindrical faces of the body and rim; the packing being first compressed on the periphery of the body, and the rim then adjusted upon the latter. The body is sectional, having two webs bolted together; one belongs with the hub, and the other is fitted in a rabbet thereon. Each portion has a flanged rim,

the combination of the two forming an annular seat for the tire. The interposed packing is intended to absorb the jar.

d is a wheel cast in three separate pieces, consisting of a rim and two portions, each of which latter has a hub and a web, between which the inner flange of the rim is gripped and bolted.

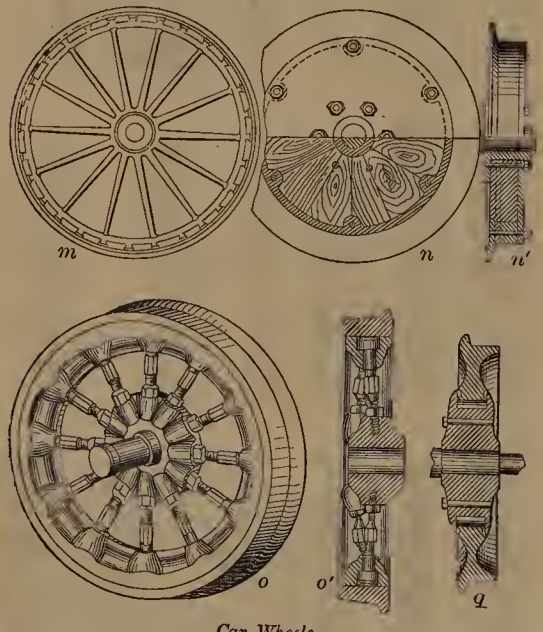
The wheel *e* has side-plates cast in one piece with the hub and cross-pieces, which connect the peripheries of the side-plates. The encircling tire is secured by rivets.

In the wheel *f*, the tire has pins upon its inner side, which enter slots in the rim of the wheel, to hold the tire from shifting. The flange-piece has a shoulder projecting on the inside, that fits in a circular groove in the body of the wheel, to which it is bolted.

The wheel *g* has a circular recess to receive a collar on the axle, over which is bolted a covering annular disk. This device is to allow the revolution of one of the wheels upon the axle in curves of the track.

h is a car-wheel constructed in two parts: first, a rim with two flanges forming an inner recess; and, second, a hub with a web, and flange upon the web,

Fig. 1171.



Car-Wheels.

flaring slightly outward. Slots in this flange (the circumference of which is slightly larger than that of the inner edge of the rim) permit it to spring past the flange of the rim into the inner recess. This device dispenses with the use of bolts, and gives elasticity to the wheel.

i and *j* are two forms of wheel, in each of which the cast hub and rim are connected by corrugated wrought-metal disks.

k is the Raddin wheel, in which the entire web and rim are cast in one piece, and the inner edge of the web rests upon the hub. The hub is formed with supporting flanges or binding rings, which are bolted to each other through enlarged holes in the web, with interposed packing-rings of india-rubber to lessen tremor and jar.

l l' are two views of the Watson wheel, in which the space between the hub and the rim is occupied by a skeleton metallic frame, whose openings are filled with panels of wood compressed therein.

In the wheel *m* (Fig. 1171), wedges of wood are driven between the rim and the tire. The purpose of these, also, is to absorb jar.

n n' are views of a compound wheel in which segments of wood form a web between the hub and the rim, being secured and strengthened by metallic plates.

o o' are views of a wheel in which the hub and rim are of cast-iron united by wrought-iron spokes, each alternate spoke leaning at an angle from opposite sides of the central circumference of the hub to the central line of the rim.

q is a wheel somewhat similar to *k*, in which the web of the wheel is inclosed between binding-plates, and has a packing between itself and the plates, and also on its inner edge.

Paper also enters into the composition of some car-wheels. The paper is tightly pressed in as a packing between the steel tires and the cast-iron hubs, so as to form a compact, strong, and yet somewhat resilient, material, which deadens sound and diminishes the force of concussion.

"There are in daily use, on the 37,000 miles of railway in the United States, not less than 1,250,000 truck and car wheels, under 8,500 locomotives, 6,500 passenger-cars, 2,700 baggage and express cars, and 160,000 freight-cars.

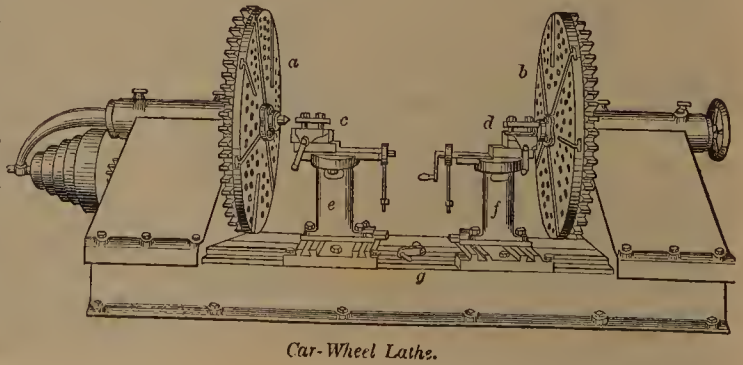
"The available statistics show that passenger-cars make an annual mileage of 28,400 miles, or $88\frac{75}{100}$ miles per day of 320 days per annum; the average load borne on each car-wheel to be $3\frac{1}{3}$ tons. With this load the average life of a wheel is 45,000 miles, or $1\frac{58}{100}$ years. On trains running at express speeds, the average life does not exceed 10 months' service, while wheels under tender-trucks have a life of 18 months. Under freight service in the State of New York, with an annual train-mileage of 11,483,123 miles, transporting 75.5 tons of freight per train, the annual mileage per car was 14,649 miles, each wheel bearing an average load of 1.47 tons, which gives 3.08 years as the life of a freight-wheel, corresponding with the experience of one of the principal roads in the State.

"But, assuming the average life of car-wheels, under all kinds of service, to be five years, the total number of wheels worn out annually in the United States will not be less than 250,000.

"At an average cost of eighteen dollars per wheel, allowing about one half for the value of the old wheel, the annual loss may be stated at two and a quarter millions of dollars." — W. G. HAMILTON.

Car-wheel Fur'nace. One in which cast-iron car-wheels are heated, and then cooled slowly, so as

Fig. 1172.



Car-Wheel Lathe.

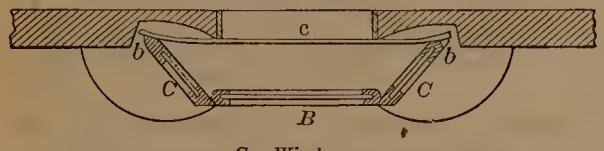
to anneal them, and render them less brittle. See ANNEALING-FURNACE.

Car-wheel Lathe. One which is adapted for turning off the rims of two driving-wheels after they have been pressed on to the axle; or for turning off the wheels separately. *a b* are the face-plates, 8 feet 6 inches apart, and forming head-stocks separately geared and independently driven, if desired. *c d* are the tools mounted in the slide-rests *e f*, which are adjustable on the bed *g*.

Car-win'dow. (*Railway.*) Car-windows are usually arranged to lift, and, being light, have no counterpoises.

Ventilating car-windows are made to open at the side towards, for the time being, the rear of the car,

Fig. 1173.



Car-Window.

so as to cause an induced draft from the interior by the rushing past of the air when the car is in motion.

The frame of the window projects sufficiently far from the body of the car to admit of there being applied to it, on each side, a valve or side window *C*, which can be opened or closed as desired, and retained in either position for the purpose of ventilating the car.

The side windows *C* vibrate on hinges at *b*, and are retained in position by the spring *c*, either open or closed against the front window *B*.

Car-win'dow Fast'en-ing. A spring-bolt which holds a car-window sash at any required elevation, according to provision of holes in the casing for the reception of the bolt.

A cam or snail-shaped piece secured to the face of the sash, and binding by the weight of the same against the beading, to hold the sash at any elevation.

Car'y-at'i-des. (*Architecture.*) Female figures placed as columns to support an entablature. Male figures in this position and relation are called *Atlantes*, *Telamones*, or *Persians*.

Cas'ca-bel. (*Ordnance.*) The rear portion of a gun, embracing the *knob*, *base*, and *base-ring*. The *cascabels* of ships' guns have *breeching-loops* in place of knobs, intended for the *breeching*, whose ends pass to ring-bolts on each side of the port, and whose duty is to limit the recoil.

Cas-cade'. A pyrotechnic device to imitate sheets or jets of water. Chinese fire is used.

Case. 1. (*Printing.*) Types are arranged in a *case*, which is a tray with compartments for the letters. Two pairs of *cases* are allowed to a compositor, and constitute a *frame*; one pair contains Roman letters, and the other italics.

The sizes of the compartments are unequally proportioned, as some letters occur more frequently than others. It is also designed to place those compartments most frequently resorted to nearest to the ordinary position of the hand, so that expedition may be secured. The proportion of English letters in a case is as follows: —

a, 8,500	e, 12,000	i, 8,000	m, 3,000
b, 1,600	f, 2,500	j, 400	n, 8,000
c, 3,000	g, 1,700	k, 800	o, 8,000
d, 4,400	h, 6,400	l, 4,000	p, 1,700
q, 500	t, 9,000	w, 2,000	z, 200
r, 6,200	u, 3,400	x, 400	See FONT.
s, 8,000	v, 1,200	y, 2,000	

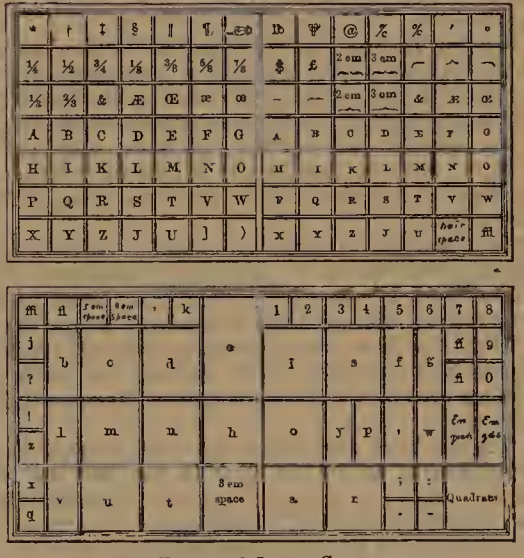
The lower case, as arranged for an ordinary work in English, has 54 boxes of different sizes; these contain the various small letters (hence styled "lower-case letters"), the marks of punctuation, the figures, and spaces and "quadrats" of different sizes. The upper case has 98 boxes of uniform size. These contain the capitals, small capitals, and various characters which are in frequent use, such as parentheses, stars, and other signs of reference, dashes, dollar and pound marks, and so on.

Fig. 1174

Printer at Case.

In the upper case the letters are arranged in alphabetical order in the lower rows, the capitals on the left, the small capitals on the right. In the lower case the letters are not arranged in alphabetical order, but in such a way as to bring those most frequently used directly in front of the compositor. To get a *j* or *z* the hand of the compositor must pass over a space of nearly three feet, while to get a *t* or *e* it traverses only three or four inches. If the letters were arranged in alphabetical order, the work of composition would be at least doubled.

Fig. 1175.



Upper and Lower Case.

Besides these usual sorts, there are many others not unfrequently employed, such as accented vowels,

superior figures ($^{1\ 2\ 3}$ etc.), superior letters ($^{a\ b\ c}$ etc.), fractions, and many others, about a hundred in all. These are usually kept in a separate case.

2. (*Bookbinding.*) A cover made ready for its contents, — the book.

3. (*Masonry.*) An outside facing of a building, of material superior to that of the backing.

4. (*Joinery.*) *a.* An inclosing frame; as, the sash-casing; a hollow box on the sides of the frame, in which the weights work.

b. The frame in which a door is hung. *c.* The inclosure of a stair.

5. (*Weaving.*) The pulley-box of a button-loom.

6. (*Pyrotechnics.*) The paper cylinder or capsule of a firework.

7. (*Mining.*) A small fissure which lets water into the workings.

Case-bay. (*Carpentry.*) The space between a pair of girders or two principals of a roof or ceiling.

Case-hard'en-ing I'ron. A process of cementation which converts the surface of iron to steel. It differs mainly from the manufacture of true steel in the different lengths of time employed, and in the depth to which it extends. Case-hardening is effected by packing the article to be hardened in a box with charcoal, ground or broken bones, particles of horns, rawhide, or tanned leather. The closed box with its contents is placed in an enveloping fire in a furnace. The fuel is preferably charcoal. The longer the heat is kept up, the deeper will be the action of the cementing materials. This process is lengthy, and not always convenient. Frequently all the mechanic requires is a thin coating of indurated metal on the outside of the article, which will not be subject to ordinary abrasion or the action of a file.

A simple method of case-hardening small cast-iron work is to make a mixture of equal parts of pulverized prussiate of potash, saltpetre, and sal-ammoniac. The articles must be heated to a dull red, then rolled in this powder, and afterwards plunged into a bath of 4 ounces of sal-ammoniac and 2 ounces of the prussiate of potash dissolved in a gallon of water.

Sheehan packs a layer of limestone in the bottom of the box, and then layers of a composition alternating with and inclosing the iron to be steelified. The composition is, — charcoal saturated with water, 200; chloride sodium, 30; sal soda, 12; pulv. rosin, 5; black ox. manganese, 5; mixed. Lute on the top, heat, remove while hot, and plunge into cold water.

Case-knife. A large table-knife. It was formerly kept in a case or sheath, and the name is a remembrance of the good (?) old times when every guest carried his own knife to the feast, helped himself from the joint, was innocent of forks or napkins, and finished by using it for picking his teeth or settling accounts with his neighbor after picking a quarrel.

"Many were the tables [at the London Lord Mayor's feast, 1663], but none in the hall but the Mayor's and the Lords of the Privy Council that had napkins or knives." — PEPYS.

"The food of the Celtæ consists of loaves of bread and meat floating in the broth, broiled on the coals or roasted on spits. They grasp the meat in both hands, but in a cleanly manner, and gnaw at it like lions; if any part is too tough to be torn, they draw their case-knives, with which each is provided." — POSIDONIUS; quoted in the "Deipnosophists" (A. D. 220).

"Their platters are of earthenware, silver, brass, wood, or basket-work." — IBID.

Case-lock. A box-lock screwed on to the face of a door.

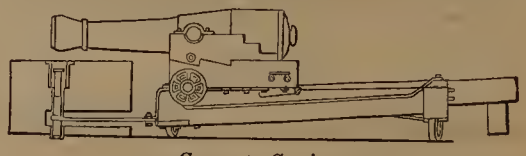
Case'mate. 1. (*Fortification.*) A vault of mason's work in the flank of a bastion or elsewhere in a fortification.

Casemates with embrasures are *defensible casemates*. *Barrack* and *store casemates* are bomb-proofs for shelter and supplies.

2. (*Joinery.*) A small hollow molding or cove, equal to about $\frac{1}{4}$ to $\frac{1}{6}$ of a circle. See MOLDING.

Case'mate-gun. A gun is mounted in casemate when it is placed in a protected chamber and fires

Fig. 1176.



Casemate-Carriage.

through an embrasure. The construction of the carriage differs somewhat from that of the barbette.

Case'mate-truck. (*Vehicle.*) A truck for transporting guns, etc., in casemate galleries or through posterns. The bed consists of two longitudinal rails forming the sides of the body, united by three transoms. The whole rests on four wheels or rollers of cast-iron, and is guided by means of a tongue.

Case'ment. A sash or glass frame opening on hinges and revolving upon one of the vertical edges. A *French* window.

Case-pa'per. The outside quires of a ream.

Case-shot. *Case-shot*, or *shrapnel*, as they are frequently termed, from the name of the English officer by whom they were introduced, about 1808, are a thin species of shell filled with bullets, and having a fuse which is so cut or arranged as to burst the case about sixty yards in front of the object fired at, so as to scatter the bullets over a considerable space. This, under favorable circumstances, is a very efficient projectile, and would be still more so were it possible to cut the fuse to such exactness as to always explode just at the desired point. The shot are sometimes placed in a tin cylinder with a wooden sabot, and used without a fuse at ranges of 300 yards. This is distinctively known as *canister*.

Case-wind'ing Watch. Theurer, of Switzerland (United States patent, February 6, 1866), has a watch so constructed that the opening of the cover winds up the works. It cannot be overwound.

Guizot, April 12, 1870, rotates the case on its pintle, to wind the watch.

Case-work. (*Bookbinding.*) A book glued on the back and stuck into a cover previously prepared.

Cash'er-box. (*Glass-manufacture.*) A table covered with coal cinders, on which the globe of glass is rested while the blowing-tube is detached and a rod attached to the other pole of the globe, preparatory to *flashing*. See CROWN-GLASS.

Cash'mere. (*Fabric.*) *a.* A fine shawl fabric formerly made only in the valley of Cashmere, but now made in many parts of the Punjab. The best are yet made in Cashmere. It is made of the downy wool of the Thibet goat, dyed in various colors before weaving.

Several accounts have been given of the process adopted by the natives in weaving the shawls. It is sometimes woven in comparatively narrow strips, which are afterwards joined. The figures are put in by the shuttle in those of superior quality, and by the needle in those of a lower description. It appears that the waters of a canal flowing from the

Lake of Cashmere have something to do with imparting the peculiar softness to the fabric.

The process is extremely slow; one account states that a single shawl occupies three men for six months. Another account states that the plain shawls only are worked by the shuttle, and the colors are all inserted by needles through the shed of the warp, a separate needle being used for each color. The work is passed through a number of hands, as customary in that old country; the merchants buying the yarn and employing weavers, who receive from 3 to 24 cents a day. The overseer of a shop receives the latter handsome amount, from which he boards himself. Eighty thousand shawls are supposed to be about the annual produce of the kingdom.

Cashmere shawls made from the imported wool of the goat are made in Paris, Lyons, and Nismes. The Jacquard loom is used, drawing the colored threads to the surface as required. The colored threads floating at the back of the shawl in the intervals of their appearance on the face are subsequently cut off, and the cut ends reveal the imitation.

A French loom has been invented for the purpose of avoiding this difficulty and making both sides alike. The yarns of the weft are not only equal in number to the colors of the pattern, but separate bobbins are provided for each repetition of a color across the shawl. Each bobbin or *pirn* stops at the end of the figure, and returns on its track after crossing the track of the adjoining bobbin. Thus the weft is made up of an interlocked series of threads, each occupying a short portion of the length of the weft, according to the limits of its figure in the general design.

The Hindoo shawl, so called, is made in France, of a *silk* chain, and *cashmere-down* filling.

In other varieties, the weft is silk and down; and at Nismes, spun silk, Thibet down, and cotton are all worked up together.

b. A woolen and cotton figured dress-goods, named in imitation of the cashmere fabric.

Cash-me-rette'. (*Fabric.*) A lady's dress-goods, made with a soft and glossy surface in imitation of cashmere.

Cas'ing. 1. (*Metal-working.*) The middle wall of a blast-furnace. Beginning from the inside, we find, the *lining*, *stuffing*, *casing*, and *mantle*. See BLAST-FURNACE.

2. (*Shipbuilding.*) The cylindrical curb around a steamboat funnel, protecting the deck from the heat.

3. (*Blasting.*) A wooden tunnel for powder hose in blasting. *Hose-trough; auget.*

Cask. 1. A large wooden vessel made of staves held together by hoops, and having heads retained by grooves in the interior perimeter of the cask, near the chines.

Casks are of various proportions and shapes. The larger are known by specific names, as the vats and tuns of the brewer and distiller; smaller are the pipes, butts, puncheons, and hogsheads for wine, etc.; smaller still is the barrel, which has almost superseded in the United States all other kinds of casks for the commercial transportation of liquids, such as whiskey, petroleum, vinegar, etc. Least are kegs and drums. A cask knocked down, and the staves and headings bundled and hooped, is known as a *shook*.

The wood for casks is sawn into lengths, and these into narrower pieces, called *codlings*. These are *listed* or hewed to give them a taper towards each end. They are then *cleft* into staves by a *frow* and *maul*. They are then *dressed* to give the convex exterior, concave interior surface. Then *jointed*, which gives the shape to the edges, so that, when drawn in at the *chines*, the staves shall fit closely against each other.

A *splayed* cask is one having a flaring or conical form.

A *bulged* cask is one swelling at the middle.

In the dry climate and with the limited timber of Egypt, casks for liquids were but little used, but some of their dry measures were made of staves and hooped wood or metal.

"The chief freight [of the boats on the Euphrates] is wine, stored in casks made of the wood of the palm-tree." — HERODOTUS, I. 194.

2. (*Dyeing.*) One form of steam-apparatus for steaming cloths which have been printed with a mixture of dye-extracts and mordants, in order to fix the colors. It is a hollow cylinder, within which the cloths are suspended for the application of the steam admitted to the interior of the drum.

Cas'se-gra'ni-an Te'le-scope. A form of the reflecting-teleseope in which the great speculum is perforated like the Gregorian, but the rays converging from the surface of the mirror are reflected back by a small convex mirror in the axis of the teleseope, and come to a focus at a point near the aperture in the speculum, where they form an inverted image, which is viewed by the eye-piece screwed into the tube behind the speculum. See TELESCOPE.

Cas'si-mere. (*Fabric.*) A single-width men's woolen goods, twilled and oil-finished. *Kerseymere* is probably a corruption. *Kersey* is a local name for a coarse worsted cloth of Scotland and Ireland.

Cas'si-nette. (*Fabric.*) A cloth made of a cotton warp and a weft of fine wool or wool and silk.

Cast. Warped. Said of sprung timber.

Cas'ta-net. A clapping instrument, composed of two little saucer-shaped disks held in the hand and beaten with the middle finger, generally as an accompaniment to the dancing of the player.

These were used by the virgins in the ancient hymns to Diana.

"They make a noise like castanets."
HERMIPPUS.

"Strikes with nimble hand
The well-gilt, brazen-sounding castanets."
Song to Diana, quoted by DICÆARCHUS.

The Phæacians, in Homer, had a dance in which their figures were accompanied by the bystanders, who made a clapping noise with their forefingers. — ATHENÆUS.

The *crotala*, or wooden clappers, were common in Egyptian musical processions, as were also clapping of hands, cymbals, tambourines, and tam-tams.

The little cymbals played with the finger and thumb in the manner of castanets are shown in the paintings of Herculaneum, and are used in the *Almeh* dance of modern Egypt.

The modern *bones*, which give so much vivacity to the negro minstrelsy, especially the factitious article on the stage, have their ancient and modern analogues in regions and times far remote. Round-headed pegs are seen in the hands of some of the dancing figures in the paintings of Herculaneum, and similar instruments of wood are used by the Japanese. In ancient Egypt a similar effect, without the rapidity of execution, was attained by the maces, which were hollow, metallic, and sonorous, and in the illustration, from which the accompanying cut is derived (a tomb in Thebes), the player is beating time for a group of professional dancers.

The castanets are used in many of the national dances of the countries bordering on the Mediterranean, and the use extends east of this district as far as China. They are used by the bayadeers in India,

Fig. 1177.

Egyptian Maces (from Thebes).

and the professional dancing-girls of Java, who are painted entirely white, and whose performances are rather attitudinizing than dancing; undulatory motions of the body, arms, and head taking the place of the agility of the legs and feet.

The first suggestion of the castanets may have been the practice of snapping the fingers in keeping time, wooden pins being afterwards substituted as being more effective, the players striking their little maces together as they met or crossed in the evolutions of the dance. The castanet, thus originating, became of a festive and votive character, while the heroic cymbal seems to have originated in warlike dances such as the Pyrrhic, Corybantian, and Persian, where swords and shields were struck and clashed in furious imitation of the scenes of war. See CYMBAL.

The mural sculptures of Nineveh show large bodies of men welcoming the king by advancing in military order, clapping their hands in time to the rhythm of the pæan. The attitude of the men forming the platoon reminds one of the modern Shakers.

Dancing was originally of a religious character, and has been introduced into the religious services of all nations and nearly all times. In many countries it is practiced, as a part of the temple services, by professionals only, as the bayadeers of India; or by fanatics, as the dervishes of Moslem lands. In Oriental countries, as also in ancient Rome, it is considered unbecoming the gravity of men, and they regard it absurd for persons who can afford to hire dancers to give themselves so much trouble.

The idea of dancing as a festive entertainment practiced by the guests seems to be European, though some of the pictures of ancient Egypt indicate that the guests danced at their assemblies.

Miriam and her *troupe* of females danced as a votive exercise in celebration of the deliverance at the Red Sea, and used as accompaniments the musical instruments of Egypt.

Without occupying space by citing the saltatorial and posturing exercises of the nations of antiquity, it may be briefly mentioned that in the early centuries of the Christian Church the dance was combined with the hymn. This was, no doubt, a concession to the Pagan habits of the people. Scaliger says that the bishops led the dance, and dancing in churches was common till the twelfth century, and in some Catholic countries till the seventeenth century.

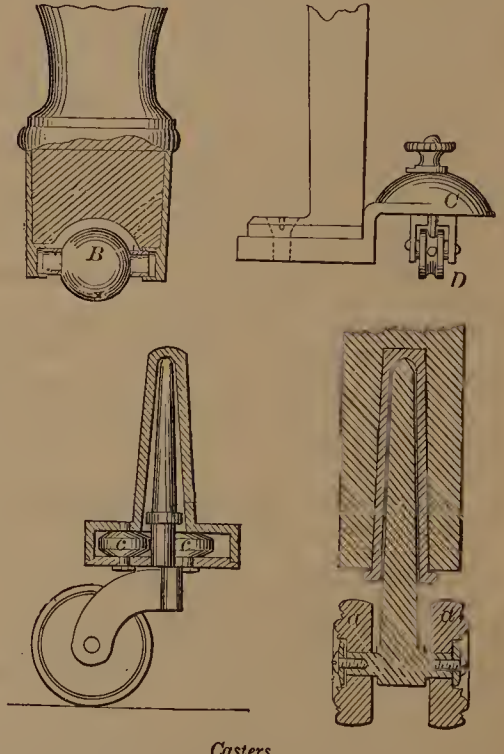
The Mohammedan religion forbade dancing in mosques 1,000 years before it was discontinued in churches. The Koran promises no dancing in Paradise, nor any other active employment. "Repose yourself for a moment," said Derar to Caled; "you are fatigued with fighting with this Christian dog." "O Derar," said the indefatigable Saracen, "we shall rest in the world to come. He that labors to-day shall rest to-morrow." So they fought on by the walls of Damascus.

Cast'er. 1. A small wheel attached to the leg of a table, chair, or other piece of furniture, in order to facilitate its being moved about without lifting.

It turns on a vertical pivot as well as on its axis. It is not easy to determine whether the circular objects beneath the feet of the chair of Rameses III. are casters or merely balls in the grasp of the claws which form the chair-feet. It is in the tomb of the kings of Thebes, and the great Sesostris is represented in his private apartments. The chair is a folding one, the X-legs being pivoted on a horizontal bar at their intersections.

The illustration shows several kinds: a piano-leg caster, having a ball *B* with trunnions; a sewing-machine caster, in which the wheel *D* is attached by a domed bracket *C* to the leg; a table-leg caster having anti-friction rollers *c c*; a caster with a pair of wheels *a a*.

Fig. 1178.

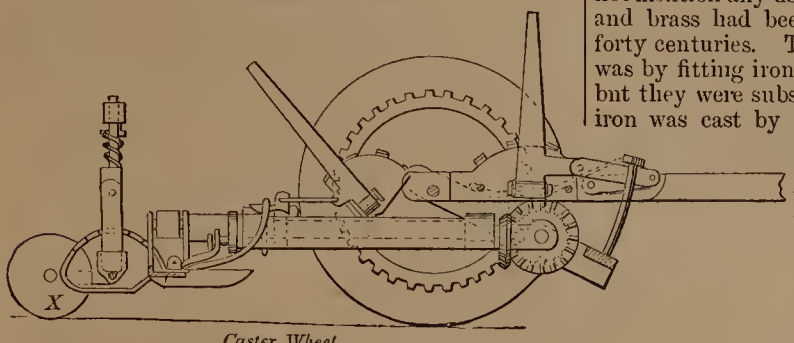


Casters.

2. A stand to hold cruets.

Cast'er-wheel. This wheel is adapted to rotate on its axis in the stock in which it is journaled, and the stock itself rotates on a vertical axis, according to the direction of propulsion of the carriage or article to which it is attached. The caster-wheel is used as a support to the front parts of machines, such as harvesters, gang-plows, spading, digging, excavating, and plowing machines, to enable them to be steered or to turn short around at the end of the

Fig. 1179.



Caster Wheel.

row. The illustration shows the caster-wheel *X* at the forward end of a harvester.

Cas-til'ian Fur'nace. (*Metallurgy.*) A lead-smelting furnace invented by Goundry (English), but first used in Spain. Its chief peculiarity is the arrangement for running off a constant stream of slag for future treatment, the slag running into cast-iron wagons, which succeed each other as their predecessors become filled. — URE, Vol. III. pp. 689–692 (Am. ed.),

Cast'ing. Scattering references to the casting of metals are found in the Greek writers. The paintings and sculptures of the Egyptian tombs have failed to throw any light upon the subject of the process. A multitude of cast bronze figures are in the European collections, and in the Abbott Collection of the N. Y. Historical Society, New York City. It is probable that the shaping of metal by the hammer, chisel, and graver preceded that of casting into molds of specific form. Pausanias declares that statues beyond the reach of the smith's art were made piecemeal and the portions fastened together. He supposes the statue erected by Ulysses to Neptune to have been thus constructed. He ascribes the art to Rhœcus and Theodorus, of Samos, in the time of Polycrates (555 B. C.), the patron of Pythagoras and Anacreon.

Bronze castings of Egyptian and Etruscan workmanship, and of great antiquity, are found, but are not identified with any date. The bronze statues of both nations, in all probability, antedate the foundation of Rome, 753 B. C.

The casting of the bronze vessels and ornaments for the service of the Temple at Jerusalem was about 1004 B. C., and took place in the clay ground between Succoth and Zeredatha. This is far more ancient than the Grecian annals, and the calf-idol cast by Aaron was five hundred years earlier still. It was an old art in Egypt.

With the exception of the statues of cast-iron referred to as mentioned by Pausanias (about A. D. 120), and regarded as curiositics, the ancients seem to have had no knowledge of the uses of cast-iron. It was regarded as in a transition stage, and was destined to be made malleable by continuous processes of heating and hammering. Pausanias says: "The temple of the Great Mother at Sparta is said to have been built by Theodorus the Samian, who first discovered the art of casting iron and making statues of it." "At Delphi is dedicated a Hercules and Hydra, both of iron. To make statues of iron is most difficult and laborious, but the work of Tisagoras, whoever he was, is really admirable. In Pergamus are the heads of a lion and a boar, both of iron." Theodorus is understood to have lived in Samos before it was merged into the Greek Empire, which took place when it was conquered by Athens, 440 B. C. A work on iron and steel written in 1550 does not mention any use for cast-iron; castings in bronze and brass had been known and used for certainly forty centuries. The early mode of making cannon was by fitting iron bars together and hooping them, but they were subsequently cast of bronze. British iron was cast by Ralph Page and Peter Baude in Sussex in the year 1543.

In 1612, 1613, and 1619, patents were granted in England for the use of coal in iron-casting. The first two were unsuccessful, and the last would appear to have been successful, as it provoked the usual results, — a mob tore down the establishment. The writer does not recollect any account of the tearing down of a shop where a supposed perpetual-motion engine was domiciled.

Emmanuel Swedenborg, in his "Regnum Subterraneum" (1734), credits the English workmen with the first successful casting of iron cannon at various foundries in Kent and Sussex. Workmen from these parts carried the art to Perigord in France. The only use for iron castings at that time was for ordnance.

Members of the Society of Friends started iron-works at Coalbrookdale, in Shropshire, England, early in the eighteenth century. Their religious principles forbade their casting cannon, and they devoted their metal to peaceful usages and equipments; casting fire-grates, boilers, and numerous articles of medium size. Many difficulties seem to have beset the workmen, in regard to the making of flasks, the selection of a suitable loam and parting; and the eventual success is connected with a pleasing episode in the history of mechanical industry, which is substantially as follows: —

About 1709, Abraham Darby, of Bristol, had a Welsh boy in his service named John Thomas. The master had been endeavoring to cast iron with but indifferent success, and the boy stated that he saw through the difficulty. They stayed after the workmen had left, and cast an iron pot in a mold of fine sand with a two-part flask, and with air-holes for the escape of steam, etc. From 1709 to 1828 a business partnership was maintained in the persons of themselves and their descendants, and the process is stated to have been kept secret at Coalbrookdale till about 1800. From the terms of the account, it would seem to have been hollow-ware that particularly bothered them; and no one who is acquainted with the art of casting iron-ware of that description will wonder at the difficulties that attended the first attempt, or withhold the meed of praise due to the success of the man and his boy.

An Abraham Darby erected the first iron bridge in 1777; it spanned the Severn near Coalbrookdale with a single arch. It is believed that at these works coke and coal were first successfully used in smelting iron.

Very small iron castings are made at Berlin, Germany, known as the Berlin iron ornaments and chains. One exhibited in London was 4 feet 10 inches long, had 180 links, and weighed 1⅞ ounces.

Professor Ehrenberg, the renowned microscopist, states that the iron of which they are composed is made from a bog iron-ore, and that the sand is a kind of tripoli, also containing iron. Both are composed of the remains of animalcules.

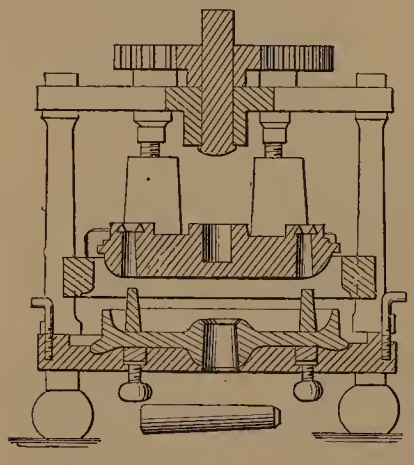
The origin of these interesting works of art was during the struggle between Prussia and France under Napoleon I. The generous ladies gave up their jewels to purchase the necessary armaments, and received in return iron ornaments which bore the

inscription, *Ich gab Gold um Eisen,* — "I gave gold for iron."

An anvil block weighing 280,000 pounds, to be used with a 44,800-pound double-action forge-hammer was cast at Newcastle-upon-Tyne.

To obtain the best result in compact metal-castings, destitute of porosity and with sharp definition on the angles and ornaments, *casting under pressure* has been devised. See Hollingrake's English patent, 1819.

Fig. 1180.



Casting-Machine.

In one case the molds are so arranged that the top part serves as the follower of a press, and is operated upon by screws. The top fits closely into the matrix, and is provided with ingates for the metal, which are closed by slides when the mold is full. The pressure is applied to the metal while in a melted state, by means of the screws, with sufficient force to expel the air and gas from and solidify the metal.

In Smith's process of compressive casting, the thing to be copied, say a page of type, is placed face upwards on a flat brass plate, and then coated all over with a preparation of potter's clay worked in with a brush. When the whole face of the article to be molded has been covered, the plate carrying it is placed on the bed of a screw-press. A brass box is locked round it, and this box is filled up for about two inches with pottery clay, sifted in and slightly rammed down. The whole is then put under the tympan of the press, and squeezed hard by two men operating the handles of the screw. The box is then opened, and out comes a flat tile with the model still fixed in it. The model is withdrawn by a little suction apparatus of india-rubber, and we have an exact *facsimile* of the model, ready, when dried, to be cast from. Nothing can exceed the beauty of the result produced by the casting of the metal under pressure in the mold thus prepared. Screws and nuts which never had a tool put on them leave nothing to be desired in the way of accuracy and completeness.

In the English patent (No. 3,197, January 28, 1809), the molds for casting are upright and made to revolve on pivots or spindles while the metal is poured in. The centrifugal force causes the metal to fill up all the parts of the mold.

In an American patent of 1857, the car-wheels are revolved so that the first metal poured in is made to form the tread of the wheel, and a second portion to form the body of the wheel.

In Bessemer's patent the metal is poured into a revolving cylinder whose rapid rotation causes it to collect on the inside of the same, when it is allowed to cool. It is then split open and rolled flat.

Castings of great delicacy are produced by using models of wax. These are imbedded in molds made of fine ground earth, which are then heated red-hot. The mold is baked, the wax disappears, and the metal, when poured in, exactly takes its place. The wax model is often made in a gelatine mold, which, being very elastic, will slip off the original object which is to be copied into metal.

With large hollow castings, such as the cylinders of the larger class of low-pressure steam-engines, both the *core* and the *cope* are built up.

For specific index of terms, processes, and appliances in casting, see FOUNDING.

Cast'ing-box. (*Founding.*) A flask containing the mold. See FLASK.

Cast'ing Clay-ware. (*Pottery.*) Delicate objects, which cannot be readily molded by pressing the clay into the mold, are cast by the following process.

The plaster mold being closed, the *slip* or creamy clay is poured in, and the portion nearest to the mold becomes hardened by the absorption of the water by the mold. The fluid portion is then poured out, and the mold partially dried. A second filling of slip yields another coating, and the process is repeated as often as may be necessary to give the required thickness to the casting.

Cast'ing-la'dle. (*Founding.*) An iron vessel with handles for conveying molten metal from the cupola and pouring it into the mold.

Cast'ing-press. One in which metal is cast under pressure, as in the car-wheel press (Fig. 1100, CASTING).

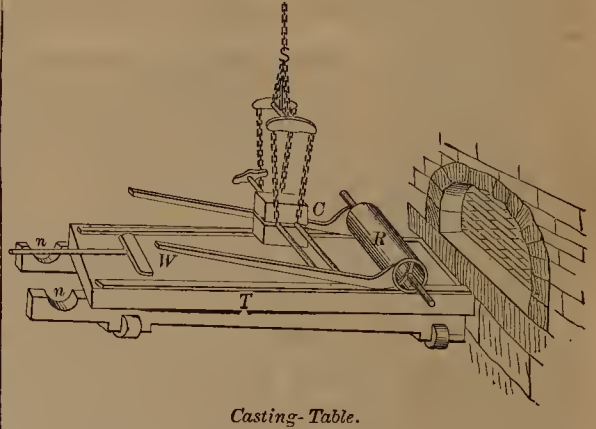
Cast'ing-slab. (*Glass-manufacture.*) The flat piece on which the metal is poured in making plate-glass. The *casting-table.*

Cast'ing-ta'ble. (*Glass-manufacture.*) The table in a plate-glass factory upon which the molten glass is poured from the *cuvette,* and rolled to a thickness by a roller which rests upon the marginal ledges of the table, whose hight determines the thickness of the plate. See PLATE-GLASS.

The table *T* is of cast-iron, perfectly level and smooth, and placed or mounted so that the plate may be delivered into the mouth of an annealing-oven at the same elevation.

The *cuvette C* containing the molten glass is con-

Fig. 1181.



Casting-Table.

veyed by a traversing crane from the oven, where its contents have been settling for several hours, and, being brought over the table, is tipped by means of the tongs, so as to spill its contents upon the table. The roller *R* is then set in motion, so as to flatten out the mass of glass. At the sides of the table are ledges, which elevate the roller to a given distance above the table, and thus determine the thickness of the glass. The standing position of the roller is at the far end of the table, as represented; and as it

passes forward, it compresses the glass in a wave before it, driving any surplus over the end of the table, where it falls into water. A washer *W* is passed immediately in front of the glass, to clear the table of all impurities. The roller then rests in the grooves *n n*.

The plate is then shifted into the oven, where it remains five days to anneal.

Cast-i'ron. 1. A compound of iron and carbon.

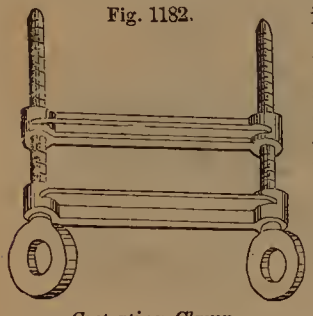
2. Iron run from the smelting-furnace. *Pig-iron.*

3. Iron melted and run into molds. See CASTING.

Cas'tor. (*Fabric.*) A heavy milled cloth for overcoats.

Cas-trat'ing-clamp. Used in confining the chords and vessels in the operating of orchotomy by excision of the parts, as in the case of the horse.

Fig. 1182.



Castrating-Clamp.

"It is a custom peculiar to all the Scythian and Sarmatian tribes to castrate their horses, in order to render them more tractable." — STRABO, VII. v. 1.

The metallic tourniquet-clamp is furnished with set screws and a peculiar pair of lips or guides.

The practice of castrating calves and pigs was usual in Greece.

Athenæus, in the "Deipnosophists," says: —

"And how much better a paunch of a castrated animal is, Hipparchus tells us: —

"'But above all I do delight in dishes
Of paunches and of tripe from gelded beasts,
And love a fragrant pig within the oven.'

"Sopater says in his 'Hippolytus': —

"'But like a beauteous paunch of gelded pig,
Holding within a sharp and biting gravy.'"

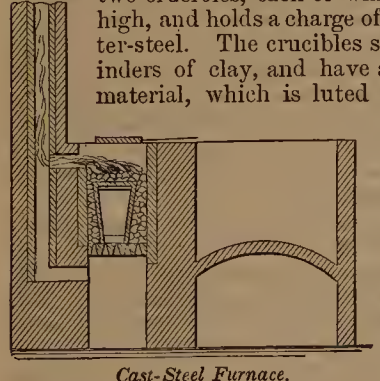
Cast-steel. Blister steel which has been broken up, fused in a crucible, cast into ingots, and rolled.

The blocks of steel are melted in crucibles of refractory clay, and the molten metal is poured into ingot-molds of cast-iron. These are opened, to let out the red-hot ingot, which is then passed to the rolls. See CRUCIBLE; INGOT-MOLD.

The process of making cast-steel was invented by Benjamin Huntsman, of Attercliff, near Sheffield, England, in 1770.

Cast-steel Fur'nace. The furnace has a strong wind-draft, and is lined with a very refractory composition. Each furnace is adapted to contain two crucibles, each of which is about 2 feet high, and holds a charge of 30 pounds of blister-steel. The crucibles stand on short cylinders of clay, and have a lid of the same material, which is luted to the top of the crucible, a little glass being sprinkled on the joint for that purpose. The fuel is coke, and the time occupied in melting is four hours. The heat generated in the cast-steel furnace is said to be greater than in any other manufacture. For some purposes the ingots are made much larger than the weight stated, even as high as 200 pounds. For the heavy forgings, such as the Krupp guns, some hundreds of crucibles are used. Four or five tons of coke are used in melting one ton of steel. Wootz is a cast-steel made from magnetic ore, in crucibles.

Fig. 1183.



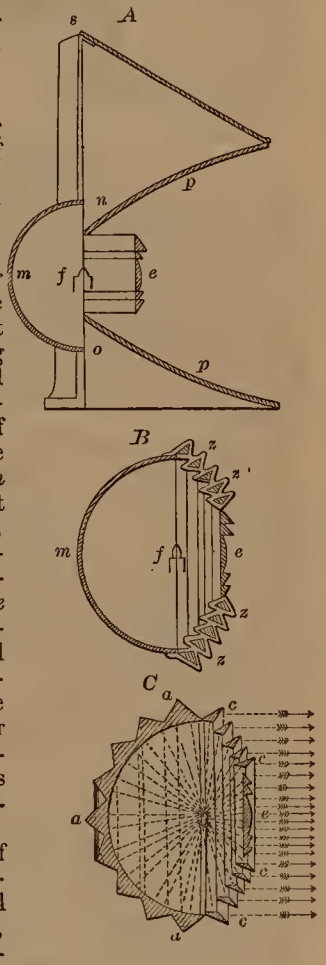
Cast-Steel Furnace.

The crucibles are withdrawn by tongs and grasped by other tongs, lifted, tipped, and emptied into the *ingot-mold*. The pouring is called *teaming*. The mold is opened while the ingot is yet red-hot, and the steel is passed to the rolling-mill. The ingot-mold separates longitudinally, and the parts are held together by collar-clamps and wedges. See CEMENTATION FURNACE.

Cat. (*Nautical.*) The tackle by which the anchor is raised to the *cat-head*. The block is the *cat-block*; the rope, the *cat-fall*.

Cat'a-di-op'tric Light. A mode of illumination for lighthouses in which reflection and refraction are unitedly employed. Suggested by Allan Stevenson in 1834. From their subjecting the whole of the available light to the corrective action of the instrument, they have been called *holophotal* lights.

Fig. 1184.



Catadioptric Light.

The accompanying figures illustrate in brief the main mechanical features of this apparatus.

A is a central section, in which the anterior cone of rays is made parallel by the lens at *e*, and the remaining zone by the paraboloid surfaces *p p*. The posterior hemisphere of rays is received on the hemispherical mirror *m n o*, and by it is sent back to the focus *f*, whence, passing onward, it is in part reflected by the lens *e* and partly by the paraboloid surfaces *p p*, and finally emerges horizontally in unison with the light from the anterior hemisphere. *s* represents one of the struts for supporting the reflecting-plates *p p*.

B is another form of the apparatus, consisting of a hemispherical mirror *m* and a lens *e*, having totally reflecting zones *z z* between them, instead of the paraboloid surfaces *p p* of the other figure.

C is another form, in which the hemispherical metallic reflector is replaced by a polyzonal hemisphere, of which each concentric zone *a* has a catadioptric action, like that which is exerted upon rays falling at right angles on the longest side of a right-angled triangular prism. A ray proceeding from the focus falls on the concave or first surface, enters without refraction, is totally reflected at the second surface in a direction tangential to the sphere at the apex of each zone, and, passing on, is again reflected at the third surface, and finally emerges from the opposite end of the inner or concave surface without

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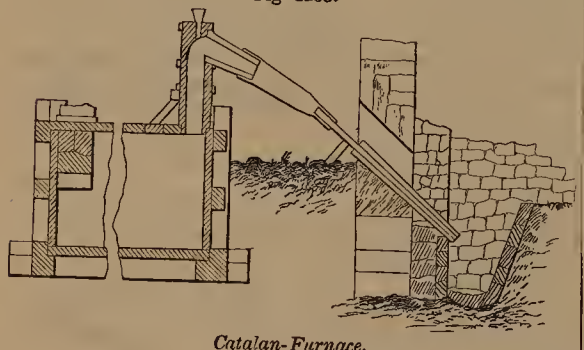
refraction; whence, passing on through the center of the hemisphere, it becomes a portion of the *anterior* cone of rays, and, being refracted through the lens *e* or reflected by the catadioptric rings *c c*, finally emerges in the paths shown by the *arrows*, and adds its power to the effect of the pencils of rays.

Cat'a-drome. A machine for hoisting heavy weights.

Cat'a-graph. The first draft of a picture.

Cat'a-lan-furnace. A blast-furnace for reducing iron ores, extensively used in the North of Spain, particularly in the province of Catalonia,

Fig. 1185.



Catalan-Furnace.

from whence it derives its name, and whence it was probably introduced into Southwestern Europe.

It consists of a four-sided cavity or hearth, which is always placed within a building and separated from the main wall thereof by a thinner interior wall, which in part constitutes one side of the furnace.

The blast-pipe comes through the wall, and enters the fire through a tuyere which slants downward. The bottom is formed of a refractory stone, which is renewable.

The furnace has no chimneys.

The blast is produced by means of a fall of water, usually from 22 to 27 feet high, through a rectangular tube, into a rectangular cistern below, to whose upper part the blast-pipe is connected, the water escaping through a pipe below.

This apparatus is exterior to the building, and is said to afford a continuous blast of great regularity; the air, when it passes into the furnace, is, however, saturated with moisture.

This apparatus is called a *trompe*. A longitudinal vertical section of the furnace, and of the lower part of the trompe, by which the blast is regulated, is shown in Fig. 1185.

Cat'a-lys'o-type. (*Photography.*) A calotype process in which the paper is first prepared with a syrup of iodide of iron, instead of the iodide of potassium. The name was given to the process to indicate the supposed fact that the gradual self-development of the picture is the result of a catalytic action. The true chemical reaction is now understood.

Cat'a-ma-ran'. (*Nautical.*) *a.* It is formed of logs usually three in number, the middle one the largest, and all secured by three lashings. The logs are slanted for cutwaters, and the raft — for such it is — is sometimes from 20 to 25 feet long and 2½ to 3½ feet wide. They land and push off through surfs, on the Madras coast, which would swamp even the country boats. In moderate weather they carry matting sails by means of an outrigger.

They may be seen on the west coast of South America many miles out at sea, carrying Indians employed in fishing.

b. The incendiary rafts prepared by Sir Sidney Smith for destroying the French flotilla at Bologne, 1804, were called catamarans. The flotilla was constructed for the invasion of England by Bonaparte; the floating carcasses were a failure; but for his own

Fig 1186.

Catamaran.

reasons the general broke up his camp and transported his troops to the Rhine. The capitulation of Ulm and the battle of Austerlitz soon followed.

Cat'a-me'ni-al-sack. A receptacle for the catamenia.

Cat'a-pult. An ancient engine for hurling stones or darts. It is usually represented as a cross-bow on a large scale.

Cat'a-ract. (*Steam-engine.*) A regulator invented by Smeaton for single-acting steam-engines.

The *plug-tree* in its ascent draws upon a cord, and lifts a piston in a vertical pump-barrel whose foot is submerged in water; a valve at the foot of the barrel admits the water thereto. The up-stroke having ceased, the piston rests upon the water, and a discharge-valve opens. The rate of discharge is regulated by the load on the piston or the size of the aperture. When the plunger passes a certain point, it makes the changes which readmit the steam, the plug-rod having no effect in so doing, as its connection is flexible. By the means of this device, called a *cataract*, the time of admitting steam is regulated by the flow of a certain quantity of water through an opening, and is entirely independent of the engineer, of the pressure of the steam and other contingencies, provided that sufficient pressure is maintained to run the engine at all.

If the boiler steam be at an unusual tension, the stroke may be made faster, but the interval between strokes depends upon the hydraulic device described. See CORNISH STEAM-ENGINE.

A modification of this is introduced into marine engines for softening the fall of the expansion-valves. A brass cylinder is filled with water or oil, and fitted with a solid piston connected by a cross-head with the valve-spindle. The fall of the valve is checked and regulated by the escape of the water or oil through a small hole bored for that purpose in the side of the cylinder, the piston of the cataract descending according as the liquid is forced out from before it by the pressure due to the weight of the expansion-valve. See CUT-OFF.

Cat'a-ract-knife. (*Surgical.*) A small keen-edged knife used in the operation of removing cataracts by extracting the crystalline lens entirely.

When the opaque body is removed and light admitted for the first time to the organ, the retina receives a new sensation, but much time elapses before the person is able to appreciate form or distance; this is a matter of practice and experience.

Cheselden the oculist gives an interesting account of a person blind from birth and brought to light at a mature age. An account is given in Mark viii. 22 – 26, of a blind person upon whom a miracle was performed by which he became for the first time sensible of light. Being asked "if he saw aught," he replied, "I see men as trees, walking"; that is, he saw something moving, but had no perception of relative form or distance, whether the object was a man or a tree, near or distant. A second and more wonderful miracle (v. 25) gave the eyes their functional power, the nerves and brain the true perception of the image on the retina. This was beyond the skill of the oculist.

A successful operation for cataract was performed, in the 25th Nivose (January 14), 1799, in the Hospice des Villards, Paris, on a man aged twenty-four, born blind. The operator was Citizen Fortenze, according to the affected style of the day.

Cat'a-ract-nee'dle. (*Surgical.*) A pointed instrument used for depressing the crystalline lens in the operation of couching.

Ca-tarrh'al-syr'inge. A nasal irrigator or douche as a remedy for or alleviator of catarrh.

Cat-beam. (*Shipbuilding.*) The longest beam in a ship. The *beak-head* beam.

Cat-block. (*Nautical.*) A two or three fold block, iron-bound, with a large iron hook attached to it, employed to draw the anchor up to the cat-head. On the forward side of the shell of this block are two small eye-bolts, for the purpose of fitting a small rope, called the back-rope bridle, used in hooking the cat.

Fig. 1187.

Cat-Block.

Catch. A spring bolt for hinged doors or lids.

Catch-bar. (*Knitting-machine.*) A bar employed to depress the *jacks*.

Catch-ba'sin. A cistern at the point of discharge into a sewer, to catch heavy and bulky matters which would not readily pass through the sewers, but which are removed from time to time. The catch-basin in the example has several receptacles, which combine to fill the space, and are separately removable, to assist in the discharge. The central cylinder is shown in the position of being raised.

Catch-bolt. A cupboard or door bolt which yields to the pressure in closing and then springs into the keeper in the jamb. Usually retracted by a small knob.

Catch-Feed'er. (*Hydraulic Engineering.*) An irrigating ditch.

Catch'ing-hook. A crochet-hook.

A crook or animal-catching hook.

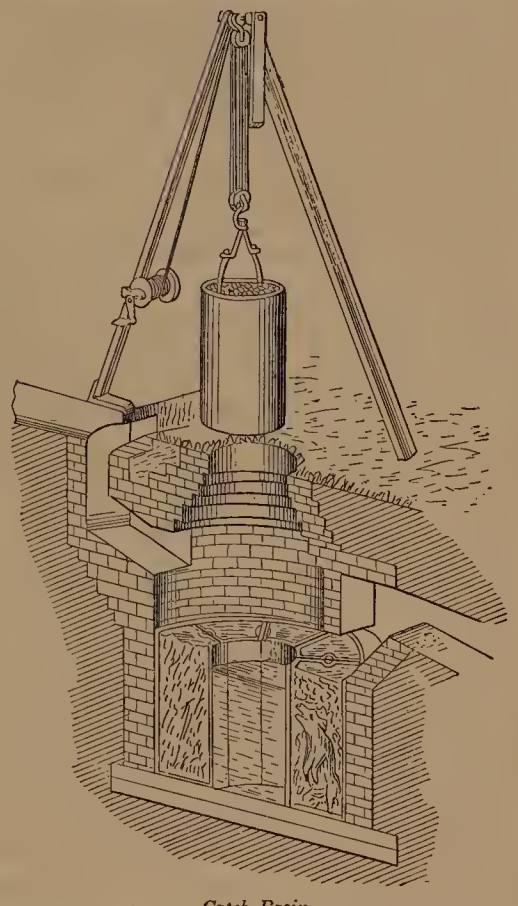
Catch-mo'tion. (*Machinery.*) A motion in a lathe by which speed is changed.

Catch-wa'ter Drain. A drain to intercept waters from high lands, to prevent their accumulation upon lower levels.

Water thus intercepted and carried off may have an effective and rapid fall to the outlet, whereas, if it were allowed to find a lower level, it might require the aid of machinery to lift it to get rid of it.

This plan of intercepting water also lessens the extent of an inundation.

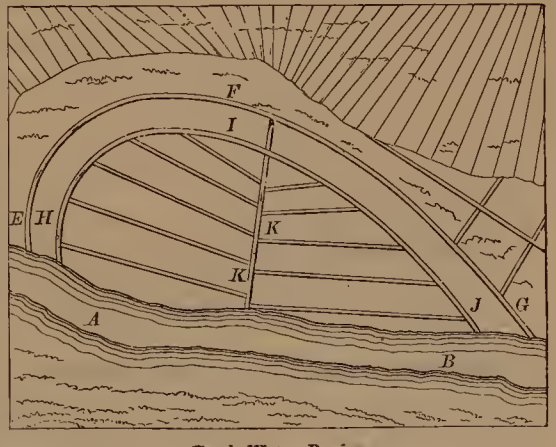
Fig. 1188.



Catch-Basin.

In the illustration, *E F G* is the *catch-water drain*. *H I J* is a parallel main drain. *K* a main drain, into which the smaller ones empty. *A B* the river.

Fig. 1189.



Catch-Water Drain.

Catch-work. (*Hydraulic Engineering.*) A water-way for flooding artificial meadows.

Cat'e-lec'trode. The negative pole of a voltaic battery.

Cat'e-na-ry. The curve assumed by a cord, wire, or chain, hanging freely between two points of suspension.

Galileo suggested that it was the proper figure for an arch of equilibrium. In this the great Florentine, as usual, was correct.

It is now universally adopted in suspension-bridges. Each wire assumes its own catenary curve, and the cable is formed of bunches of aggregated strands.

Formerly they were made to form arcs of circles.

Cat-fall. (*Nautical.*) The tackle by which the anchor (by its ring) is suspended from the *cat-head* in hauling up.

Cat'gut. Twisted intestines of animals. Those of the poor Italian sheep are preferred to those of better-fed animals of other countries.

The guts, taken warm from the animal, are cleaned, freed from adherent fat, and rinsed in pure water. They are then soaked for two days, scraped with a copper plate having a semicircular notch, beginning at the smaller end. This removes the mucous and peritoneal membranes. The guts are then soaked, again scraped, washed, steeped in weak lye (two ounces to the gallon), passed through a polished hole in a piece of brass, to equalize the surface, twisted, dried, and sorted. They may then be dyed or sulphured, and rubbed with olive-oil.

Catgut is used for violin and harp strings, as whip-cord, bow-strings, clock-cords, lathe-cords, etc.

Other guts are used for coarse purposes. Horse guts are split into four, cleaned, twisted, etc., for lathe-bands.

Strong catgut is made of a number of strips of gut twisted together. By another process the clean gut is *blown*, dried in the open air or under sheds, and then compressed, moistened, sulphured, and twisted.

Cath'a-rine-wheel. (*Pyrotechnics.*) A form of firework having a spiral tube which rotates as the fire issues from the aperture. A pin-wheel.

Cat-harp'ing. (*Nautical.*) One of the ropes by which the shrouds are drawn towards the mast below the tops, to allow the yards to swing clear when close-hauled.

Iron cramps are now usually employed, still, however, retaining the name.

Cat-head. (*Shipbuilding.*) *a.* An inclined timber projecting from the bow of a ship, forming a crane-arm from which the *bower anchor* is suspended when raised from the water.

The tackle used in *hauling-up* is called the *cat-fall*, and is hooked to the ring of the anchor.

In preparing to *let-go*, the anchor is suspended from the *cat-head* by means of a rope called the *cat-head stopper*. See ANCHOR-TRIPPER.

The inner end of the *cat-head* is made fast to a beam or frame, and is termed the *cat's tail*.

The sheaves for the *cat-fall* run in mortises in or near the outer end of the *cat-head*.

b. (*Mining.*) A miner's name for a small capstan.

Cat-head Stop'per. (*Nautical.*) The rope or chain by which the ring of an anchor is secured to the cat-head. A device for casting it loose and thereby freeing the anchor is an ANCHOR-TRIPPER (which see).

Cath'e-ter. A tube which is introduced through the urethra, to evacuate the contents of the bladder.

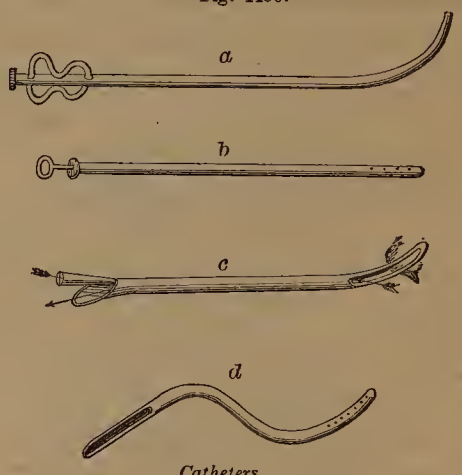
They are specifically adapted (*a*, *b*) for male and female patients.

Some are adapted for the introduction of caustic, constituting a *porte-caustic*.

Catheters are also employed to enter the canal which connects a cavity in the ear with the back part of the mouth, and called the *Eustachian tube*, after its discoverer, a learned Italian physician who died at Rome, 1574.

A double catheter (*c*) is one whose outer tube has a long eye and an inner tube of smaller size, which discharges about the middle of the length of the eye of the larger one. If water be injected through

Fig. 1190.



Catheters.

the inner tube, it enters the cavity of the uterus or bladder, as the case may be, and passes out through the outer canal.

d is Sims's sigmoid catheter of hard rubber.

Male and female catheters are described particularly by Celsus, first century A. D., and have been disinterred at Pompeii. One is of the modern sigmoid form; and one is shorter, and has a single curve.

Cath'e-ter-gage. A plate with perforations of a graduated size, forming measures for diametric sizes of catheters.

Cath'e-tom'e-ter. From Greek words meaning a measurer of vertical hight. A telescopic leveling-apparatus which slides up and down a perpendicular, graduated, metallic standard. As the column of liquid rises or falls in the tube, the telescope partakes of the motion, and the differences of hight are shown on the graduated standard.

Cath'ode. That pole of the battery by which the electricity passes out of the substance undergoing decomposition. The negative or — (minus) pole. (Professor Faraday's term.)

Cat-hole. (*Shipbuilding.*) One of the holes above the gun-room ports, for passing out a hawser.

Cat-hook. (*Nautical.*) A large hook on the cat-block, for attaching to the ring of the anchor in *catting*.

Ca-top'ter. A reflecting optical instrument.

Ca-top'tric Cis'tu-la. A box with several sides, lined with looking-glasses, so as to multiply images of any object placed in the box.

Ca-top'tric Di'al. A dial which shows the hour by means of a piece of looking-glass, adjusted to reflect the solar rays upward to the ceiling of a room on which the hour-lines are delineated. A *reflecting-dial*.

Ca-top'tric Light. A mirror, or series of concave mirrors, preferably parabolic, by which the rays from one or more lamps are reflected in a parallel beam, so as to render the light visible at a great distance.

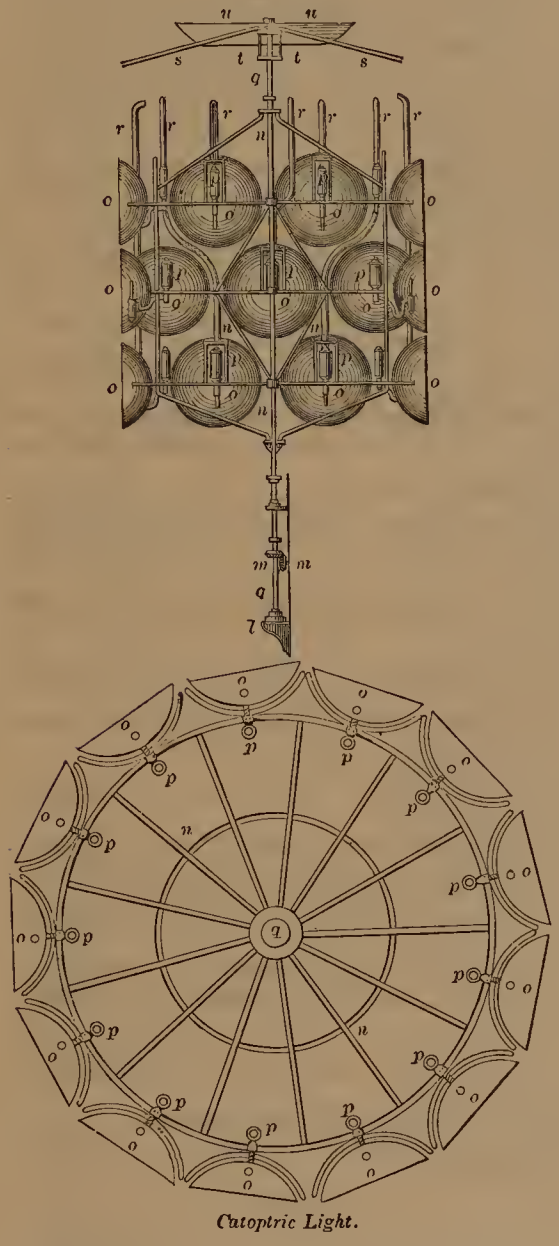
This was the arrangement universally employed in lighthouses previous to the invention of the Fresnel lens. See DIOPTRIC LIGHT; LIGHTHOUSE.

Catoptric lights are susceptible of nine separate distinctions, which are called *fixed*, *revolving white*, *revolving red and white*, *revolving red with two whites*, *revolving white with two reds*, *flashing*, *intermittent*, *double fixed lights*, and *double revolving white lights*.

The illustration shows a revolving apparatus on the *catoptric* principle. The upper figure is a side elevation; the lower figure a horizontal section.

n n shows the reflector-frame or chandelier; *o o* the reflectors with their oil-fountains *p p*. The whole is attached to the revolving axis or shaft *q*. The copper tubes *r r* convey the smoke from the lamps; *s s* are cross-bars which support the shaft at *t t*; *u u* is a copper pan, for receiving any moisture which may accidentally enter at the central ventilator in the roof of the light-room; *l* is a cast-iron bracket, supporting the cup in which the pivot of

Fig. 1191.



Catoptric Light.

the shaft turns; *m m* are beveled wheels, which convey motion from the machine to the shaft. The machinery does not require any particular notice, being that of common clock-work, moved by the descent of a weight.

The horizontal sectional view shows a plan of one tier of reflectors arranged in the manner employed in a fixed catoptric light; *n n* shows the chandelier, *q* the fixed shaft in the center which supports the whole, *o o* the reflectors, and *p p* the fountains of their lamps. In this figure (in order to prevent confusion) only one tier of reflectors is shown; the other tiers are so arranged that their axes divide into equal angles the arcs intercepted between the axes of the adjoining reflectors on the first tier, thereby producing the nearest approach to an equal distribution of the light which is attainable by this arrangement.

Cat-rake. A name for a *ratchet-drill.*

Cat's'paw. (*Nautical.*) A hitch in a rope for the attachment of a tackle.

Cat-ship. A ship on the Norwegian model, having a narrow stern, projecting quarters, and a deep waist.

Cat-tack'le. (*Nautical.*) A tackle to raise the anchor to the cat-head.

Cat'tle-feed'er. An arrangement in a cattle-stable for supplying the feed in regulated quantities to the rack or manger.

Cat'tle-guard. (*Railway Engineering.*) A ditch alongside a public road, and crossing beneath the railroad way, to prevent the straying of cattle on to the track.

Cat'tle-lead'er. A nose-ring or gripper for the septum of the nose, whereby dangerous cattle may be fastened or led.

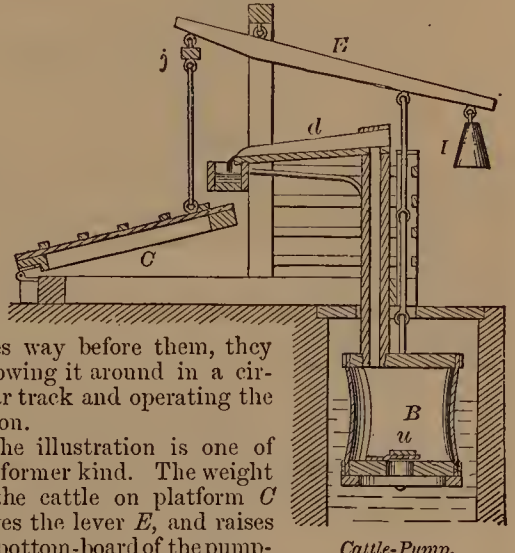
Cat'tle-mark'ing Shears. A kind of scissors adapted for making marks on cattle by cutting off the hairs in such lines as to form letters or figures constituting initials or private marks of the proprietors.

Also, scissors adapted for cutting slits or notches in the ears of cattle, sheep, or hogs, as a means of identification, familiarly known as *ear-marks.* The shears has sometimes a punch attached for making holes in the ears, for the same purpose. Time was when they marked men so.

In all pasturing countries some means are necessary for the identification of cattle running at large. On the tombs of ancient Egypt we see the cattle being branded. This is yet the practice in Texas, South America, and elsewhere. The swans in the Thames are marked by nicks on their bills. Sir John Perrot (in 1584) ordered the Irish to mark all their cattle with pitch or ear-marks, on pain of forfeiture.

Cat'tle-pump. A pump which is operated by the cattle coming to drink, either by their weight upon a platform or by pressing against a bar which

Fig. 1192.



Cattle-Pump.

gives way before them, they following it around in a circular track and operating the piston.

The illustration is one of the former kind. The weight of the cattle on platform *C* moves the lever *E*, and raises the bottom-board of the pump-chamber *B*, discharging water at the spout *d*. When the animal leaves the platform, the weight *I* helps the descent of the bottom-board, and the water passes upward through valve *u*.

Cat'tle-stall. A means for fastening cattle at

their mangers or racks, other than by halter or tie. It usually consists of a pair of parallel vertical stanchions, at such distance apart as to admit the neck of the animal. One stanchion is movable, to allow the head of the animal to pass, and is then replaced and held by a latch or pin.

The improvements in cattle-stalls refer to the floors, divisions, mangers, racks, troughs, feeding devices, ties; also to devices to prevent crib-biting, for slinging sick or refractory animals, preventing kicking.

The feeders are made in various ways: Opening automatically at regulated periods; closing, to prevent access in the intervals of feeding; arrangements for deposition in the manger of regulated quantities of feed at certain times.

Cat'tle-tie. A fastening for securing cattle at the rack or manger. The varieties are numerous. Some refer to means for releasing all the animals simultaneously in case of fire.

Different kinds of fastenings for the rope, halter, or collar-strap, by which the animal is secured; such are loops, snap-hooks, cuphroes.

Means for taking up the slack of the halter-rope, to prevent the animal becoming tangled in it and being thrown; such are falling weights and springs.

Means for fastening the hitching end of the rope to the manger, stall, post, or stanchion; such are hooks, rings, clamping-cams, latches, etc.

Other similar devices may be found under HITCHING; HALTER; TETHER.

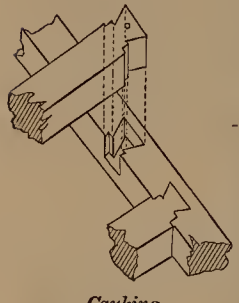
Cat'ty. The bill-hook or machete of Ceylon.

Cauf. 1. A chest with holes to keep fish alive in the water.

2. A large basket, used for raising coals from the bottom of a mine. A *corve*.

Cauk'ing. (*Joinery.*) A dovetail, tenon, and mortise-joint by which cross-timbers are secured together. It is used for fitting down tie-beams or other timbers upon wall-plates.

Fig. 1193.



Cauking.

Caul. A heated board used in laying down large veneers. Its heat keeps up the fluidity of the glue until all that is superfluous has been pressed out at the edges.

Caunt'er-lode. (*Mining.*) A lode which inclines at a considerable angle to the other contiguous veins.

Cause'way. (*Civil Engineering.*) A road across a marsh or water, supported by an embankment or by a retaining wall. In contradistinction to a viaduct, which is supported by trestle-work, or by arches or trusses resting on piers. See EMBANKMENT.

Caus'son. A nose-band or *twitch* for breaking horses. See CAVESSON; BARNACLES.

Cau'ter. A searing-iron.

Burning with a red-hot iron was practiced by the Libyans, in the time of Herodotus (450 B. C.), as a cure for salt-rheum. The practice is still in vogue there. Cautery, we learn from Denham, is "the sovereign Arab remedy for almost every disorder." We read of it in Hippocrates. Layard noticed the use in Mesopotamia; Burton among the Egyptians.

The *cautery* was a favorite surgical instrument with ancient chirurgeons. One of iron, shaped like a spade, was found by Dr. Savenko, of St. Petersburg, 1819, in the house of a Roman surgeon in the Via Consularis, Pompeii.

The cauter is used by farriers in veterinary operations.

Cau'thee. (*Fabric.*) A coarse East India cotton cloth.

Cau'ting-i'ron. A searing-iron. See CAUTER.

Cav'a-lier'. (*Fortification.*) An elevated work on the terreplein of a *bastion* serving to command the work or some other position, and also serving as a *traverse* to protect the neighboring curtains from enfilade fire.

Cav'a-lot'. A cannon carrying a ball of 1 pound.

Cave. The ash-pit of a glass furnace.

Cav'es-son. A nose-band for breaking-in horses. Otherwise spelt *causson*, *cavezon*. It resembles the *twitch* or *barnacles*, being a grip by which the nose is wrung and twisted, to subdue the refractory spirit of the animal.

Ca-vet'to. (*Architecture.*) A form of hollow molding whose profile is the quadrant of a circle. See MOLDING; SCOTIA.

A *rampant* cavetto is perpendicular.

Cav'il. 1. (*Nautical.*) A large cleat. See KEVEL.

2. A small stone axe with a flat face and a pointed peen. Resembles a *jedding*-axe.

Cav'in. (*Fortification.*) A hollow way from a protected approach to a defended work.

Cav'ing-rake. A rake for separating the chaff (Eng. *cavings*) from grain, when spread on the barn-floor.

Cax'on. (*Metallurgy.*) A chest of ores, calcined, ground, and washed, ready for the refining-furnace. From the Spanish *caxon*, *cajon*, a large chest.

Ca'zo. (*Metallurgy.*) A vessel with a copper bottom in which ores of silver are treated in the *hot process*.

Cec'o-graph. The French writing-apparatus for the blind. A *chiragon*.

Ceil'ing. 1. (*Architecture.*) The upper surface of a room.

Plane ceilings are flat.

Domed, *cylindric*, or *groined* are terms which explain themselves.

Coved ceiling has a hollow of about a quarter-circle running round the room, situated above the cornice and dying into the flat central portion.

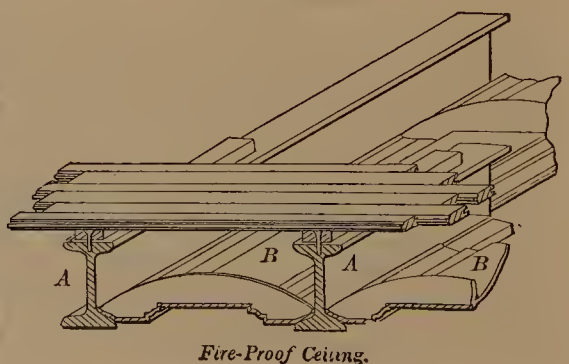
Coffer-work ceiling is arched, and has ornamental panels separated by belts.

Gothic ceilings have groined work with spandrel framing and paneling; the framing of the roof is exposed.

Sunk-panel ceiling has recessed compartments, with roses in the middle and bolection-moldings around them.

Camp ceiling has the marginal portion slanting, following the slope of the rafters, while the middle portion is flat.

Fig. 1194.



Fire-Proof Ceiling.

Fire-proof ceilings are of incombustible materials *B* supported on iron joists *A*, as in Fig. 1194.

2. (*Shipbuilding.*) That portion of the inside skin of a vessel between the deck-beams and the *limber-strakes* on each side of the *keelson*. Also called the *foot-waling*. The strakes of the *ceiling* immediately below the *shelf-pieces* which support the deck-beams are called *clamps*. The outside planking is distinctively called the *skin*.

Ceil'ing-joist. (*Building.*) One of the *joists* spiked to a *binder*, and serving as a point of attachment for the plastering laths of the ceiling.

Cel'a-ture. The art of engraving, chasing, or embossing metals.

Cell. 1. (*Architecture.*) *a.* The space between two ribs of a vault.

b. The space inclosed within the walls of an ancient temple.

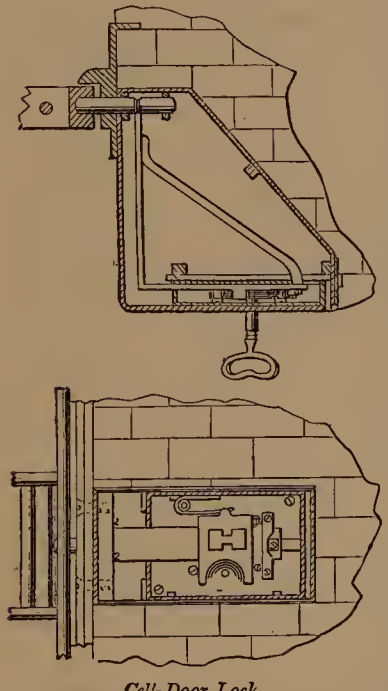
2. (*Electricity.*) A single jar, bath, or division of a compound vessel, containing a couple of plates, — say copper and zinc, — united to their opposites or to each other, usually by a wire. See GALVANIC BATTERY.

3. An underground room for storage.

4. A small room for a prisoner.

5. A structure in a wrought-iron beam or girder; a tube consisting of four wrought-iron plates riveted to angle-iron at the corners. See ANGLE-IRON.

Fig. 1195



Cell-Door Lock.

Cell-door Lock. A prison-door lock, to whose bolt no access is possible from the inside, and which may fit, as in the example, in a rabbet in the door-jamb.

The secondary bolt is supported in the inclosing shell by brackets, and is connected to the main working parts of the lock by brace-bars, so that the key gives it a movement parallel with that of the common bolt. The inclosing case has a hinged, right-angled cover, the inner fastening of which is covered by the door when closed.

Celt. The stone hammer or axe of a bygone age. Afterwards made of bronze. See HAMMER; HATCHET.

Ce-ment'. 1. A uniting composition which is plastic when applied, but hardens in place. The ingredients and character vary with the place, purpose, materials to be united, and the exposure.

ALABASTER. *a.* Plaster-of-paris, 1; yellow resin, 2; mix and apply hot, warming the faces of the fracture or joint.

b. Sulphur or shellac, melted with plaster-of-paris. Simple plaster-of-paris.

ARCHITECTURAL. Paper pulp, sifted whiting, and size. This is a sort of papier-maché, and must be varnished or painted if exposed to the weather.

ARMENIAN. See JEWELER'S, *d.*

BOTTLE. Rosin, 4; tallow or suet, 1; melt together and stir in the required coloring-matter, — whiting, ochre, or ivory-black. Use hot.

CHEMICAL. See GLASS.

CHINESE. *a.* Shellac, 1; alcohol, 2; digest in a corked bottle in warm water.

b. Borax, 1; water, 12; shellac, 3; evaporate to the required consistence.

COPPER. (To lay upon the rivets and lapping edges of copper-sheets.) Powdered quicklime, bullock's blood.

CUTLER'S. (For fixing knives in handles.) Black rosin, 4; beeswax, 1; brick-dust, 1.

DEXTRINE. Torrefied starch.

DIAMOND. See JEWELER'S, *d.*

EARTHENWARE. *a.* (Coarse.) Yellow rosin and brick-dust melted together.

b. (Finer; for certain purposes.) Brimstone.

c. Grated cheese, 2; quicklime, 1; white of egg sufficient to form a paste.

d. White of egg and quicklime.

e. Dried and ground milk-curds triturated with ten per cent of powdered quicklime. Keep from the air, mix with water for use, and apply immediately.

ELASTIC. Caoutchouc dissolved in chloroform, with or without powdered gum-mastic.

ELECTRIC APPARATUS. Beeswax, 1 lb.; rosin, 5 lbs.; red ochre, 1 lb.; plaster-of-paris, 2 oz.

FIRE-PROOF. Fine river-sand, 20; litharge, 2; quicklime, 1; linseed-oil to form a paste. Applied to walls, it becomes stony-hard.

GAS-FITTING. Rosin and brick-dust.

GLASS. *a.* Dissolve gum-mastic, 1 ounce, in alcohol; soak 1 ounce of isinglass in water; add alcohol to dissolve it to a strong glue, and add ¼ ounce of sal-ammoniac. Put the two solutions into a pipkin; heat, and stir. Put in a stoppered vial, and warm in a water-bath when about to use it.

b. (For chemical glasses.) Flour, 1 ounce; pulv. glass, 1 ounce; pulv. chalk, 1 ounce; fine brick-dust, ½ ounce; scraped lint; white of egg. Spread on a linen cloth, and apply to the crack of the glass.

c. (For a temporary stopping or lute.) Yellow wax, 4; turpentine, 2; Venetian-red, 1.

d. White of egg and quicklime. It does not long resist moisture unless exposed to the heat.

e. (For lens-grinders, etc.) Melt together, pitch, 5; wood-ashes, 1; hard tallow, 1.

Or, Black rosin, 4; beeswax, 1; heated whiting, 16.

Or, Shellac, melted.

Or, Rosin and plaster-of-paris.

f. To unite lenses, Canada balsam.

g. (To attach metallic letters to plate-glass windows.) Copal varnish, 16; drying-oil, 6; turpentine (Venice), 3; oil of turpentine, 3; liquified glue, 5; melt, and add quicklime, in powder, 10.

h. (For necks of bottles.) Linseed-meal in boiled oil. Paraffine.

GLUE. *a.* A strong glue, sold as a cement, may be made by infusing glue and isinglass in alcohol, heat gently, and add powdered chalk.

b. *Ure's* glue (dissolved), 8; linseed-oil, boiled to varnish with litharge, 4.

c. Dissolved glue, 4; Venice turpentine, 1.

d. (Waterproof.) Dissolve isinglass, 2 ounces, in a pint of milk, and boil to a consistence.

e. Glue swelled in cold water and digested in linseed-oil is tenacious, and acquires the quality of resisting moisture. Red lead may be added.

f. *Marine glue;* shellac and caoutchouc dissolved in separate portions of naphtha, and mixed.

g. *Spalding's* liquid glue; glue and acetic acid.

GRANITE. Gum-dammar, marble-dust, felspar. The mineral ingredients are reduced to an impalpa-

ble powder, and the mass is incorporated by gradual heating. It is applied warm to the warmed faces of the fractured portions. The black felspar is preferably used, to prevent the detection of the joint.

HARD. *a.* Dried and pulverized clay, 8; clean iron-filings, 4; peroxyde of manganese, 2; sea-salt, 1; borax, 1. Triturate, reduce to paste with water, use immediately; heat after using.

b. Peroxyde manganese, zinc-white, silicate of soda, to form a paste.

HYDRAULIC. *a.* The ancient hydraulic cement is the pozzuolana, a volcanic earth obtained near Baiæ, in Italy. See POZZUOLANA.

b. Hydraulic mortar or cement is made from argillaceous limestones, the presence of the alumina conferring the power of hardening under water. Hydraulic limes were known to and understood by the Romans. Attention was directed to the subject by Smeaton, when he experimented for a cement capable of hardening under water, in order to form his foundation courses for the Eddystone lighthouse.

c. The French cement made at Mendon, near Paris, is made of chalk 4 parts, clay 1 part, ground in water, settled, molded, dried, and calcined.

d. The Portland cement of England is made of chalk and clay from the valley of the Medway. The septaria and lias rocks also yield an hydraulic cement.

Artificial pozzuolana is also made from lime and clay.

e. Gad's patent (English); dried clay in powder, 3; oxide of iron, 1. Make into a paste with boiled oil. Will harden under water.

f. Mix clay, broken pottery, flint and bottle glass, into a frit; grind, sift, and mix with one third its weight of quicklime; keep from the air. In using, mix into a mortar, and apply like pozzuolana.

IRON. *a.* (For steam-boilers, cracked ovens, etc.) Litharge, 2; fine sand, 1;, slaked lime, 1. Mix, and keep dry.

b. Iron-borings, powdered earthenware, pipe-clay, salt, water.

c. Steam and water tight joints, in permanent cast-iron works, are made by an iron cement compounded as follows: Cast-iron filings or borings, 112; sal-ammoniac, 1; sulphur, 1, whitening, 4.

Small quantities are mixed with a little water just before using.

For minute cracks the cement is laid on externally as a thin seam. For larger fissures it is driven in with a calking-iron. The edges of the metal and the cement are involved in one common mass of rust, which is impermeable to steam or water.

d. Clean iron-filings, 16; sal-ammoniac, 3; flour of sulphur, 2. Mix, and keep stoppered.

In use, take 1 part of the mixture, 12 parts of new filings, add a few drops of sulphuric acid, and fill the crack or the joint which requires it.

e. Mix boiled linseed-oil, litharge, red and white lead. Apply on each side of a piece of flannel or paper, and lay the same between two pieces before they are bolted together.

f. (For fire-joints and flues.) Iron-filings, sal-ammoniac, and borax.

JEWELERS'. (For uniting the pieces of a broken gem.) *a.* Warm the parts, and place gum-mastic between them. It will melt by the heat, and will be scarcely observable.

b. (For temporarily holding a glass, set, or a piece of metal, while being shaped or chased.) Rosin, 4; wax, $\frac{1}{4}$; whiting, 4. Mix and heat.

c. Take pitch, rosin, a small quantity of tallow, and thicken with brick-dust. Stir in a pipkin over a fire.

d. (Armenian cement for uniting metals.) Dissolve gum-mastic in alcohol and isinglass (previously softened in water) in brandy, adding a little gum-galbanum, or gum-ammoniac, previously rubbed fine. Mix under heat; keep in stoppered vial, which is placed in hot water when the cement is to be used. This is *diamond cement.*

The Armenian artificers set the jewel in a metallic setting whose lower surface corresponds to the shape of the article on which it is to be placed. The two are then united by the cement.

LEATHER. (For leather and cloth.) *a.* Gutta-percha, 3; caoutchouc, 1; digested in bi-sulphuret of carbon, 8.

b. Gutta-percha, 16; caoutchouc, 4; pitch, 2; shellac, 1; linseed-oil, 2.

MARBLE. Plaster-of-paris steeped in a saturated solution of alum and re-calcined. Mix with water, and apply as plaster-of-paris. This cement or stucco is susceptible of a high polish, and may be colored to imitate marbles.

See also STONE; GRANITE; *infra.*

MASTIC (Bottger's). Sand, limestone in powder, litharge, combined, 100 parts; boiled linseed-oil, 7 parts. Mix. Similar to Loriat's French mastic, invented 1750.

MORTAR. *a.* Sharp, clean sand, 3; freshly slacked lime, 1. See BETON; STONE, ARTIFICIAL; MORTAR.

b. Parker's cement, known as *Roman*, patented in England in 1796, is made by adding a quantity of calcined and powdered argillaceous stone to the usual constituents of mortar, namely, sharp sand, lime, and water.

Cements from sulphate of lime: —

c. Keene's cement is made from plaster-of-paris mixed with a saturated solution of alum, dried, baked, powdered, and sifted.

d. Parian cement, same as above, with the substitution of borax for alum.

e. Martin's cement, same as above, with the addition of pearl-ash to the alum.

f. Stucco is a combination of plaster-of-paris with gelatine solution.

g. Scagliola is made of plaster-of-paris powdered, mixed into a paste with alum, isinglass, and coloring matter, and is incorporated with fragments of marble.

OPTICIANS'. See GLASS.

PAPER. *a.* Rice digested in water, applied hot.

b. Flour paste. A little powdered alum is said to improve its quality, and a little corrosive-sublimate or creosote to prevent its becoming moldy.

c. Mucilage of gum-arabic, thickened with starch. Used by French makers of artificial flowers and ornamental boxes. Also by naturalists in mounting specimens.

d. Sealing-wax.

e. (For postage stamps.) Dextrine and size.

PHOTOGRAPHER'S. Dextrine, paste, and glue.

PLUMBERS'. Rosin and brick-dust melted together.

ROMAN. See MORTAR, *b; supra.*

SEAL-ENGRAVERS'. Rosin and brick-dust. Melted together, and used to temporarily fasten an object to a chuck while engraving or chasing.

SLATE. (For the joints of slate-work on roofs or in tanks.) Boiled linseed-oil, white lead, chalk, intimately compounded, and used in a fluid condition.

STONE. Fine sand, 20; litharge, 2; quick-lime, 1; linseed-oil to form a paste.

See also cements, alabaster, glass, earthen, granite, diamond, Armenian, Chinese, etc., *supra.*

STOVE. (For cracks in stoves and other iron-ware.) Finely pulverized binoxide of manganese, mixed with a strong solution of silicate of soda, to form a thick paste. Fill the crack, and heat slowly.

Another: Dry clay, 4; borax, in solution, 1.

TURNER'S. (For chucking articles.) Rosin and brick-dust, melted together.

WATERPROOF. *a.* (For covering of bungs, etc.) India-rubber (digested), beeswax, tallow, and quicklime.

b. (For joining rubber goods.) Caoutchouc in naphtha or turpentine.

WOOD. 1. *a.* (For attaching a piece of wood to a chuck for turning, and for other purposes.) Rosin, 1 pound; pitch, 4 ounces; brick-dust or red ochre, to give consistence; add tallow in winter.

b. Shellac, 1; alcohol, 2. Digest in a corked bottle, in warm water.

2. (*Mining.*) The gravel cemented by clay, which lies next to the bed-rock of the ancient stream, but is now buried beneath a mass of lava and gravel-drift, sometimes many hundreds of feet in depth. This auriferous stratum is reached by timbering, draining, and hoisting, as in other underground operations, or the overlying deposits by *hydraulic mining*, which consists in washing away the superincumbent mass. This system is principally practiced in Sierra Nevada and Placer Counties, California. The *cement* of these "deep placers" is crushed by stamps, and the free gold collected by sluices or other means. See Professor Raymond's "Mines, Mills, and Furnaces."

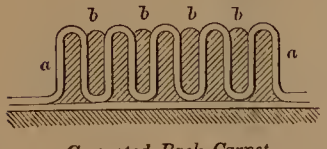
3. (*Metallurgy.*) *a.* The brown deposit in the precipitation tank, wherein the soluble chloride of gold, obtained by the *chlorination* process, is deposited by the addition of sulphate of iron to the solution.

b. The material in which the metal is imbedded in the CEMENTING-FURNACE (which see).

Cem'en-ta'tion. (*Metallurgy.*) The process of infusing a solid body with the constituents of another body in which it is buried, by the application of heat; as the conversion of iron into steel by adding to it a certain proportion of carbon. See CEMENTING-FURNACE.

Ce-ment'ed-back Car'pet. In forming cemented-back carpet a number of warp-threads *a a* are arranged in a frame, and are brought into a convoluted form by means of metallic plates *b b*, which are laid strictly parallel. The under side of the warps thus doubled or folded are then dressed to raise a nap, and this surface is then smeared with cement and backed by a canvas or coarse cloth. When dry, the metallic strips *b b* are removed by cutting the loops, and leaving a pile surface, as in the *Wilton* carpets.

Fig. 1196



Cemented-Back Carpet.

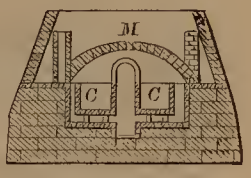
Another mode is to wind the colored yarns around wires, which are then laid parallel; one surface treated with cement and backed with canvas; the other cut like a Wilton carpet when the backing is dry.

Another mode is to fill a square box with parallel yarns laid according to a design, so that a transverse section across the yarn will show the pattern. The ends of the box being open, a piston is introduced at one to expel the yarns at the other. At the discharge-end, the surface, being cut fair, is cemented, and a cloth applied to it. A quantity of the yarn, equal to the length of the pile, is then cut off, and adheres to the backing. The surface is again cemented, the yarn protruded, the backing applied, the pile cut off, and so on.

Ce-ment'ing-fur'nace. A furnace in which an article is packed in the powder of another substance, and therewith subjected to a continued heat below the fusing-point. The article is changed by a chemical reaction with the powder.

Bar-iron, packed in charcoal and heated in a cementing-furnace, becomes steel, the iron absorbing some of the carbon.

Fig. 1197.



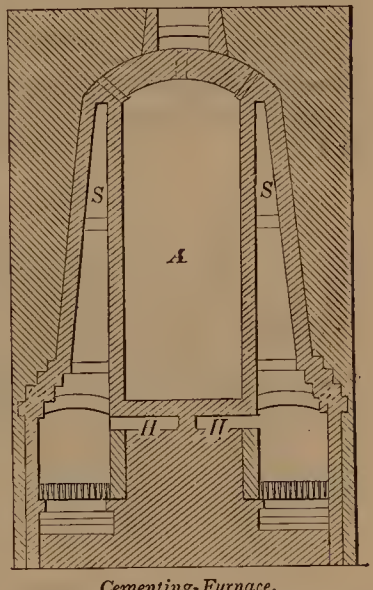
Cementing-Furnace.

Cast-iron, packed in powdered hematite and similarly heated, becomes malleable; the oxygen of the hematite absorbing some of the carbon of the iron.

The troughs *C* are so supported beneath the arch *M* of the furnace, that the fire has free access to their whole exterior surfaces. The bar-iron is imbedded in charcoal in the troughs *C*, being arranged in tiers with interposed layers of charcoal, no two bars being in contact. The tops of the troughs are covered in with fire-tiles, or the upper layer with refractory sand, and the heat is increased for several days, and then maintained for a period depending upon the kind of steel required. The finer varieties of steel are produced by a prolonged process, and the bars are sometimes exposed again and again to the process of cementation.

In Fig. 1198 is an oven for converting iron into steel. The converting-chamber *A* is surrounded at bottom and on the sides by the fire-spaces *H S*. The furnaces and grates extend along each side of the base of the converting-chamber, and from end to end of the oven, leaving an opening at each end for the admission of fuel. A longitudinal line of fire-brick prevents the draft from passing from one furnace to the other. Above the boshes the walls are made to incline inwards, in order to confine the heat more closely to the sides of the converting-chamber. At the top the spaces communicate with the interior of the converting-chamber by means of holes, which are made smaller towards the center of the chamber than at the ends.

Fig. 1198.



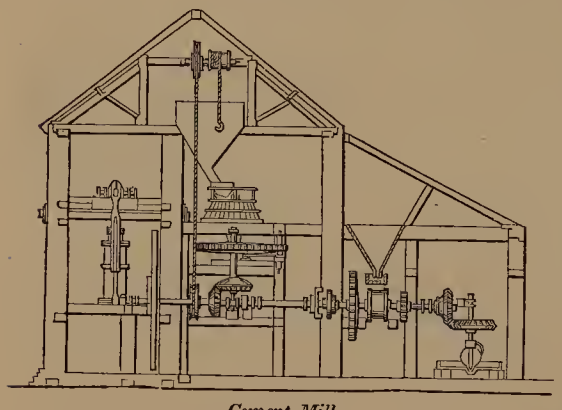
Cementing-Furnace.

Ce-ment'-mill. A mill for grinding the septaria or stony concretions from which cement is derived.

The machinery is driven by a steam-engine, shown to the left in the illustration, and the motion is communicated by a horizontal through-shaft to all the machinery in the mill. The operations exhibited are threefold. The cement-stone is crushed between a pair of rollers on horizontal shafts beneath the hopper to the right hand. Falling to the floor, it is elevated to the upper story and dumped into a hopper, from whence it passes into the eye of the runner mill-stone and is finely pulverized. The stones

have a face dressing like those for grinding grain, the oblique channels being laid over in sections. From the mill the powder passes to a pair of sieves, which receive a rapid horizontal reciprocation by a

Fig. 1199.



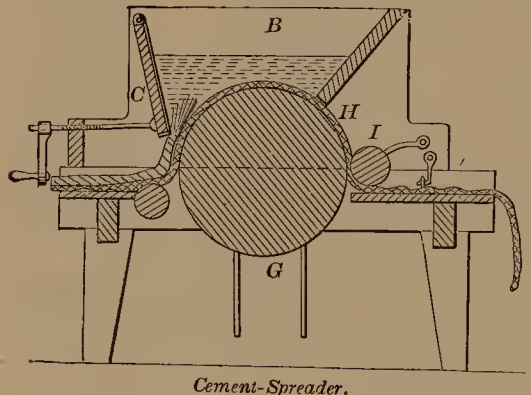
Cement-Mill.

rod and crank attached to the small spur-wheel, which is turned by the large spur-wheel on the spindle beneath the bed-stone.

To the right is shown a mortar-mill, which consists of an edge-wheel traveling in a circular bed, like that of a Chilian ore-mill. This stone has an axle which projects radially from a vertical post which is rotated by spur-gearing from the main horizontal shaft of the mill. A scraper on the stone cleans the face of the edge-stone.

Ce-ment'-spread'er. A machine for coating and saturating felt or paper with liquid cement, for roofing purposes. The cloth or paper *H* passes under

Fig. 1200.



Cement-Spreader.

roller *I* and over the roller *G* into the liquid-cement hopper *B*, and passes out between the roller and the adjustable gate *C*, which gages the quantity of cement which passes out with the cloth.

Cen'drée de Tour'nay. A hydraulic cement of aluminous quicklime and coal-ashes.

The ashes and lime from the bottom of the kiln are sifted, to remove lumps. The dust is slacked a bushel at a time till the mortar-box is filled. The mortar is then well incorporated by a pestle suspended at the end of an elastic pole. It is then partially dried, again beaten, and this is repeated from six to ten times, no more water being added. It adheres very firmly to bricks or stone, and hardens under water.

Cen'ser. A brazier or pan for burning aromatic woods and spices.

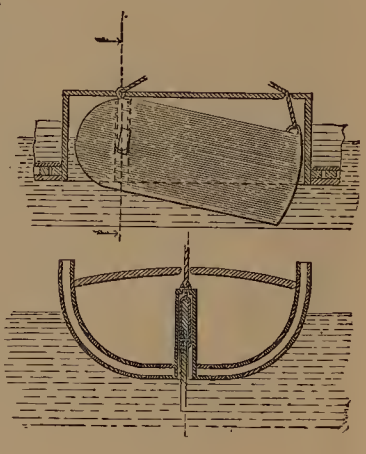
Cen'ter. (*Lathe.*) One of the points on the lathe-spindles on which the work is placed. The *front* or *live center* is on the spindle of the *head-stock*. The *back* or *dead center* is on the *tail-stock*.

The *centers* of a *planer* are on stocks temporarily attached to the bed of the planer, so that the object may be turned on its axis in the course of the work thereon.

Cen'ter-bit. A wood-boring tool which has a central pivot and two wings; one of these is a *scriber* and the other a *router*. See Bit.

Cen'ter-board. (*Nautical.*) A board placed amidship in a well which extends longitudinally and vertically through the keel, and is adapted to be lowered to give a deeper draft, in order to avoid lee-way and to give the vessel greater stability under press of canvas. It is the old Dutch lee-board in a central position. A *sliding-keel*.

Fig. 1201.



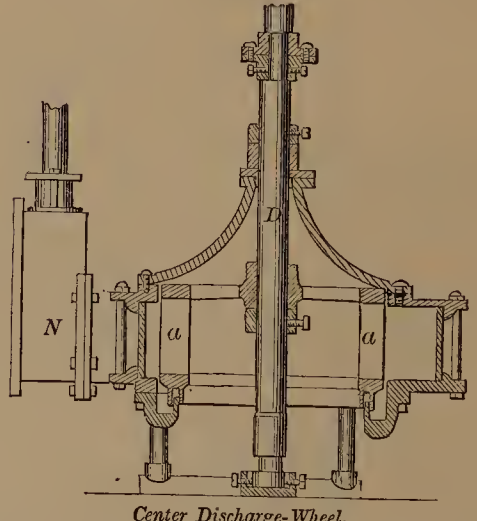
Center-Board.

Cen'ter-chis'el. A chisel used to make a dent at the exact center, to form a starting-point for the drill, in drilling holes in metal. A pointed cold-chisel.

Cen'ter-chuck. (*Turning.*) A chuck which can be screwed on the mandrel of a lathe, and has a hardened steel cone or center fixed in it; also a projecting arm or driver.

Cen'ter Dis-charge'-wheel. A form of turbine, in which the water is admitted from a chute *N*

Fig. 1202.



Center Discharge-Wheel.

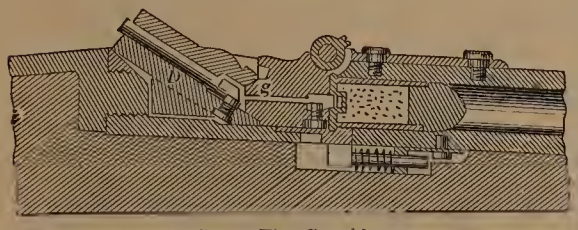
to the periphery of the buckets *a a*, passes towards the center of the wheel, and thence downward around the axis *D*.

Cen'ter-drill. A small drill used for making a short hole in the ends of a shaft about to be turned, for the entrance of the lathe-centers.

Cen'ter-fire Car'tridge. One in which the fulminate occupies an axial position, instead of being around the periphery of the flanged capsule.

In the illustration the fulminate is in a cap, and

Fig. 1203.



Center-Fire Cartridge.

is struck by a firing-pin *g*, when the hammer descends upon the end of the bolt *D*. See CARTRIDGE.

Cen'ter-gage. A gage for showing the angle to which a lathe-center should be turned, and also for accurately grinding and setting screw-cutting tools.

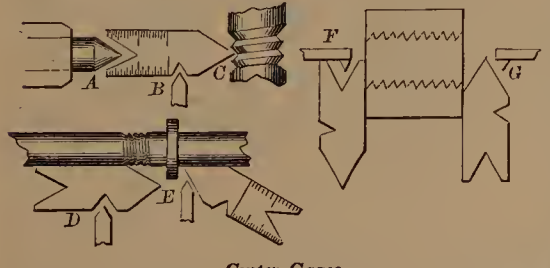
The annexed cut shows the tool, and illustrates its uses.

At *A* is shown the manner of gaging the angle to which a lathe-center should be turned. At *B*, the angle to which a screw-thread cutting-tool should be ground, and at *C*, the correctness of the angle of a screw-thread already cut.

In the lower figure, the shaft with a screw-thread is supposed to be held on the center of a lathe. By applying the gage as shown at *D* or *E*, the thread-tool can be set at right angles to the shaft, and then fastened in place by the screw in the tool-post, thereby avoiding imperfect or leaning threads.

In the right-hand figure, the manner of setting the tool for cutting inside threads is illustrated. The angles used in this gage are sixty degrees. The four divisions upon the gage of 14, 20, 24, and 32 parts

Fig. 1204.



Center-Gages.

to the inch are useful in measuring the number of threads to the inch of taps and screws.

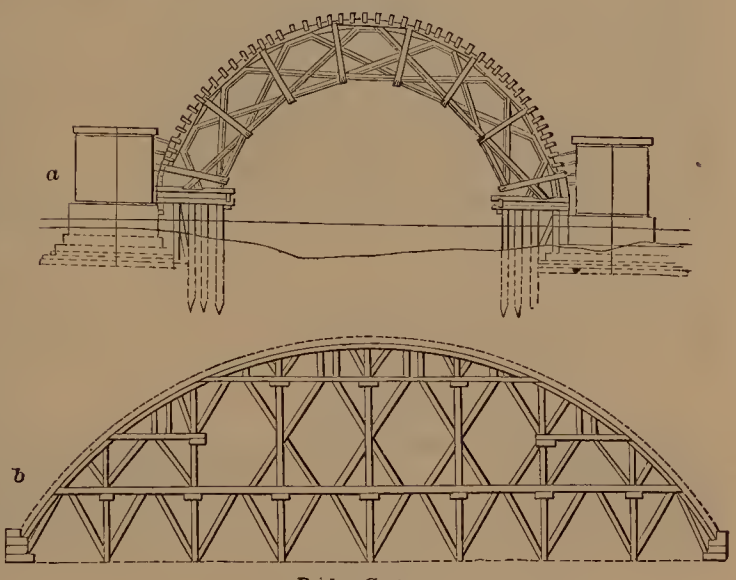
The following parts to the inch can be determined by them: namely, 2, 3, 4, 5, 6, 7, 8, 10, 14, 16, 20, 24, and 32.

Cen'ter-ing. (*Masonry.*) A temporary support, serving at the same time as a guide to the workmen, placed under an arch during the progress of its construction. Its duty is to support the arch until it has been finally closed by the insertion of the key-stone, and is able to maintain itself in position without extraneous help.

The object is to afford the largest possible amount of support to all the parts; to arrange the timbers so that each part shall be equally supported in proportion to its actual pressure, and to economize — or at least such should be the engineer's aim — timber. The centering is, in fact, a pattern, in wood, of the intrados of the finished arch, and is, in large structures, such as first-class stone bridges, an expensive erection of itself, requiring a large amount of scientific knowledge and practical skill to thoroughly fulfill the required conditions.

The essential features of a *centering* are the *ribs* which span the space between the piers; the *bolsters*, or boarding, which lie transversely and support the *voussoirs;* the *keys*, or *striking-plates*, beneath the ribs, which are struck to lower the centering; and

Fig. 1205.



Bridge-Centers.

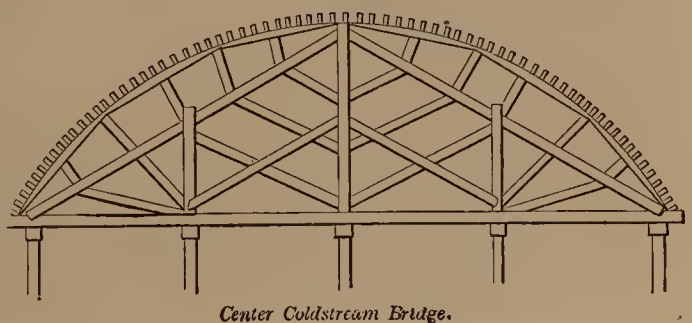
a sufficient amount of framing to hold the *ribs* and *bolsters* securely.

A cocket-centering is one in which head-room is left beneath the arch above the *springing-line*, upon which the temporary supports of the centering may have to rest.

The most elementary form may be seen in the common sewer or culvert, where a simple structure answers the purpose; but in large structures, which may have to support a pressure of many hundreds of tons, careful calculations are required, involving a knowledge of the strength of materials and resolution of thrust. Engineering skill is also necessary in securing proper foundations under the widely varying circumstances of the soil and substrata.

Fig. 1205, *a* is a center used at Westminster Bridge, an improvement on Perronet's system. Two timbers resting on the abutments incline and meet at the top, forming a large triangle; this is crossed and braced in different directions, constituting seven compartments, and affording considerable strength.

Fig. 1206.



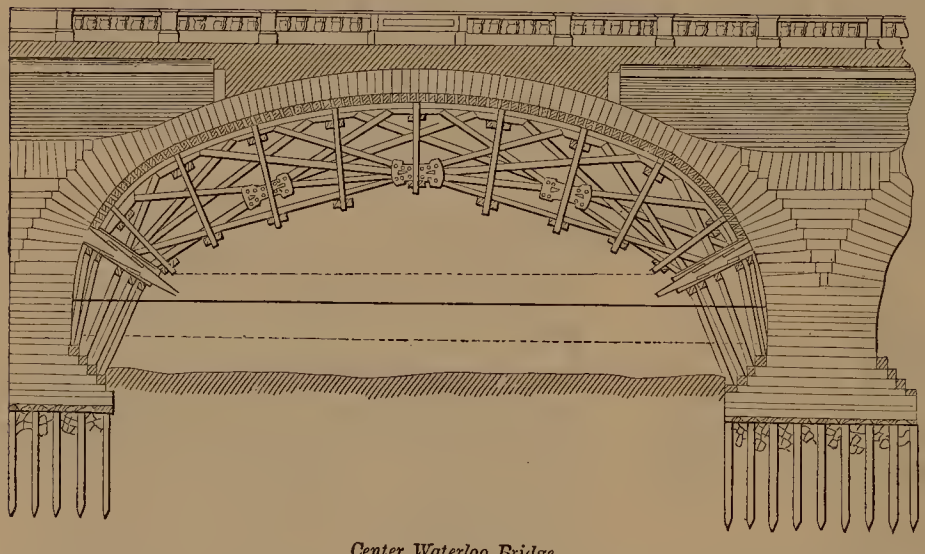
Center Coldstream Bridge.

Centers of 130 feet span have been formed by the arrangement represented in Fig. 1205, *b*, composed of vertical and horizontal timbers with diagonal braces; the upper portion is contrived to rest upon wedges, and can be lowered without disturbing the rest; by striking the inclined supports at bottom, their position can be altered when desired. These centers have the advantage of simplicity, and can be easily put together and taken down.

Smeaton's center for Coldstream Bridge resembled a roof-truss in its general arrangement, consisting of a frame with a tie-beam united by a system of braces; on each side were struts supporting the ribs, on which was laid the planking for turning the arch.

The centers devised by Rennie for the arches of Waterloo Bridge have been often cited as admirably arranged structures of their kind. Inclined "piles," which carried the weight of the ribs of the center, had their bearings on the offsets of the stone piers, which afforded an excellent abutment. The ribs were laid upon whole timbers capping the piles, and under each set of ribs wedges were introduced, which were made to extend across the whole width; when it was required to ease the center, the wedges were driven along each other, and slid down the inclined plane into larger spaces than they had formerly occupied. The whole center could by this means be made to descend very gently,

Fig. 1207.



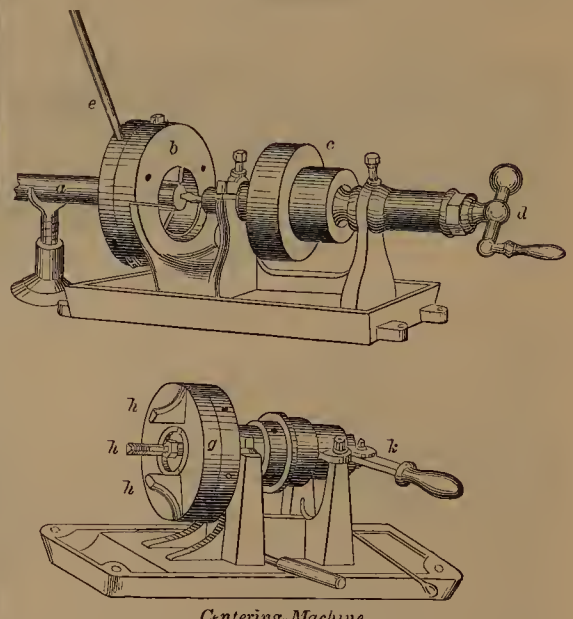
Center Waterloo Bridge.

and be retained at any required position during the progress of the work.

An elevation of the framing is shown in Fig. 1207. This center is said to have had remarkable strength, and when struck, the arch settled but a very few inches.

Cen'ter-ing-ma-chine'. A form of machine-drill for centering shafts, bolts, etc. The purposes are various, but especially to make such a depression at the exact center that the object may be placed in a lathe for turning. Two illustrations are shown. In the upper one the end of the shaft *a* rests in the crutch, and is held between the three sliding-dogs of the chuck *b*, so that the exact center of end-face is presented to the drill, which is rotated by a band on pulley *c*, and advanced to its work by the tail-screw *d*. The lever *e* is the means of rotating that portion of the chuck which carries the rack or snail by which the dogs are radially adjusted, so as to grasp or release the shaft.

Fig. 1208.

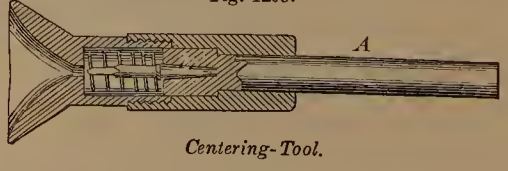


Centering-Machine.

The lower figure has the dogs *h* on the face of the chuck *g*, and these are made to embrace the shaft, bolt, or rod near the end, so as to hold it for the advance of the drill, which, in this case, is moved to its work by the lever-handle *k*, but rotated by the band on the pulley.

Cen'ter-ing-tool. One having a trumpet mouth, into which the end of a shaft may be pushed while the tool occupying the axis may be driven forward, to drill or punch a hole in the exact axial center of the rod. The shaft *A* is attached to the lathe-spindle, and around it is a sleeve supporting a centering-cup, which is driven forward by a spiral spring.

Fig. 1209.



Centering-Tool.

Cen'ter-line. (*Shipbuilding.*) A central, longitudinal, vertical section of the hull.

Cen'ter-lathe. 1. A lathe in which the work is supported upon centers at each end; one on the end of the mandrel in the head-stock, and the other, the back-center, on the axis in the tail-stock. The latter is adjustable.

2. A lathe in which the work is held by centers projecting from two posts, and is driven by a band

which passes two or three times around it. The band is fastened at its respective ends to a treadle beneath the lathe and a spring-bar above it. A *pole-lathe*.

Cen'ter-pin. The pivot on which the compass-needle oscillates. See MARINER'S COMPASS; DIP-COMPASS.

Cen'ter-punch. A punch for making an indentation, as a mark for the center of a hole to be drilled, a circle to be struck, or as a center of revolution in the lathe.

Cen'ter-rail. (*Railway Engineering.*) A third, or middle, rail placed between the ordinary rails of a track, and used on inclined planes in connection with wheels on the locomotive in ascending or descending the grade.

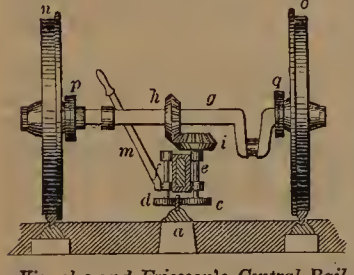
The first of these was BLENKINSOP'S patent of 1811. The middle rail was a rack, and was engaged by a cogged wheel on the locomotive by which the ascent was secured.

No particular provision was made for descent. The device was primarily intended as an aid to traction, as it was supposed at that time the bite of the drivers on the rail would be insufficient.

SNOWDEN (English), in 1824, had a center-rack and what he called a *mechanical horse*. A bevel cog-wheel on the locomotive acted upon gearing on the *horse*, and the latter had a wheel engaging the center-rack, so the *horse* was advanced and drew the train.

EASTON (English patent, 1825) specifies a central rack placed between the two rails, and a spur gear on the locomotive. In addition to this, the smooth sides of the rail form guides, lateral wheels running in a horizontal plane beneath the engine or carriage, bearing upon the sides of the rail and preventing the swerving of the vehicle from the line or rails. No positive motion was imparted by the engine to the said guide-wheels.

Fig. 1210.



Vignoles and Ericsson's Central Rail.

KOLLMAN'S English patent of 1836 has a central guide-rail.

A central *friction-rail* was patented by VIGNOLES and ERICSSON in England, 1830.

This friction-rail consists of a flat piece of iron fixed in a vertical position in chairs *a*, occupying a median position between the tracks. On each side of the friction-rail is a horizontal friction-roller, as shown at *c d*; the roller *c* being made considerably longer than *d*, and fixed upon its vertical shaft *c*, while *d* is permitted to turn freely on its vertical shaft *f*. On the driving-axis *g* is fitted a bevel-wheel *h*, which turns another bevel-wheel *i*, fixed upon the vertical shaft *e* of the driving-roller *c*. The bearings of this driving-roller and its shaft are firmly fixed to the under side of the locomotive-carriage by a block to which the bearings of the friction-roller *d* are hinged, that the latter may at pleasure be pressed against the friction-rail *a* by the lever *m*. This lever is brought within reach of the engineer. The driving-wheels *n o* may be released from the power of the engine by disengaging the clutches *p q*, so as to throw the whole force of the engine upon the gripping rollers *c d* when ascending a grade.

KOLLMAN'S Locomotive Guide, English patent, 1836, had a pair of rollers acting upon the sides of a center-rail whose upper flanges prevented the rising of the guide-rollers to such an extent as to become disengaged.

SELLERS'S United States patent, 1835, embraced a central rail, clamped between two horizontally rotating rollers driven by the power of the locomotive.

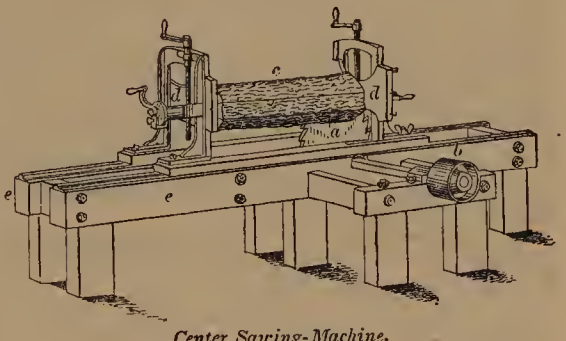
A device similar to that described in Vignoles and Ericsson's English patent, 1830, was adopted by FELL in the Mount Washington Railway, whose steep gradients could not be ascended by the ordinary means.

Mr. Fell adopted the same means in ascending the inclined planes on Mont Cenis.

Another form of center-rail railway has but a single rail in the middle of the track, and a pair of smooth tramways, one on each side, traversed by ordinary wheels.

Cen'ter-saw. A machine for splitting round timber into bolts, instead of riving it, for axe and pick handles, heavy spokes, etc. It has a sliding carriage, furnished with center head-blocks, upon which the log is placed; and is provided with a dial-plate and stops, by which the log can be spaced

Fig. 1211.



Center Sawing-Machine.

into stuff the desired size. The centers can be adjusted up or down, to suit the work. Is capable of splitting timber up to 20 inches in diameter, 3½ feet long; cuts invariably toward the center, and is calculated for a saw 22 inches or less in diameter.

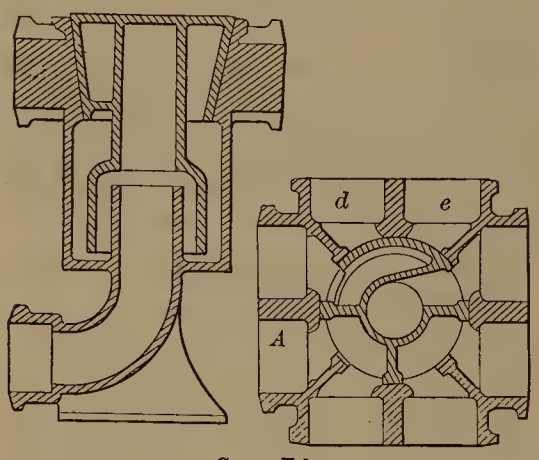
Cen'ter-sec'ond. A term applied to a watch or clock in which the *second*-hand is mounted on the central arbor and completes its revolution in one minute. It is more easily read than the ordinary second-hand traversing in its own small dial.

The beat of the *second-hand* may be seconds, or fractions of a second. In the original form it beat with the balance, a third of a second at a beat.

The largest center-second clock known to the writer is the turret-clock for the Bombay Harbor Board, which indicates hours, minutes, and seconds upon a dial 8½ feet in diameter. The center-second hand measures 6½ feet in length, and its end has a motion of 5 inches per second, acquiring a momentum which has been overcome by a series of sixty levers, so arranged that the second-hand rests in one of them at each beat; the point of the hand being so contrived that when it rests upon a lever it is detained there, and can get neither backwards nor forwards until the clock-work removes the lever out of the way. This prevents the swaying back and forth of the hand, and gives it a dead motion.

Cen'ter-valve. A device in gas-works whose duty is to distribute the coal-gas to the purifiers. In the example annexed, the seat of the valves is a casting *A*, having four pairs of mouths *d e*. The valve itself has a port which may, by rotation, be made to connect with and distribute the coal-gas to any one of the four sets of purifiers.

Fig. 1212.



Center-Valve.

Cen'ter-wheel. The "third wheel" of a watch, in some kinds of movements.

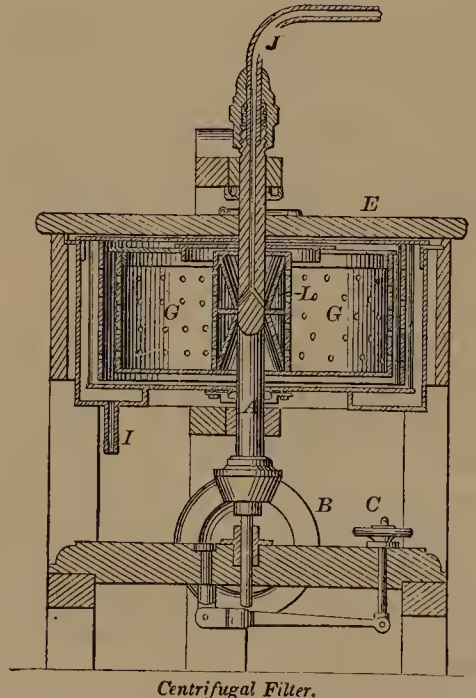
Cen'ti-grade Ther-mom'e-ter. The thermometer of Celsius. The zero is at the freezing-point of water, and the boiling-point is at 100°. See THERMOMETER.

Cen-trif'u-gal Drill. A drill having a fly-wheel upon the stock, to maintain and steady the motion against the effect of temporary impediments. In some cases there is a click movement, so that the fly-wheel may constantly maintain the same direction of motion, notwithstanding the vibratory character of the primary motion.

Cen-trif'u-gal Fil'ter. The centrifugal sugar-filter was patented in the United States by Hurd in 1844, and in England by Finzèl in 1849.

Its cylinder has a porous or foraminous periphery, and is very rapidly rotated on its ver-

Fig. 1213.



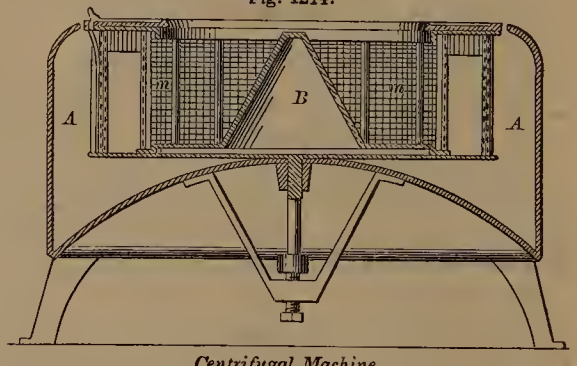
Centrifugal Filter.

tical axis, so as to drive off by centrifugal force the liquid with which the substance contained in the cylinder is saturated. In the illustration annexed, the syrup is introduced by pipe *J* into the distributor *E*, which disperses it to all parts of the chamber *G*, which is filled with bone-black and is rotated rapidly on its shaft *A* by a bevel-pinion driven by the bevel-wheel *B*. *C* is the wheel of the tram-lever, on which the shaft is stepped. The liquid driven out of the cylinder *G* is collected in the envelope-chamber, and discharged by the pipe *I*. Sugar is freed of molasses in the same kind of machine. See CENTRIFUGAL MACHINE.

Cen-trif'u-gal Gun. A form of machine-cannon in which balls are driven tangentially from a chambered disk rotating at great speed.

Cen-trif'u-gal Ma-chine'. A machine for drying yarn, cloth, clothes, sugar, etc., by centrifugal action. The fiber or other material is placed in a hollow cylinder with a reticulated periphery of wire gauze, and, being rotated at a rate of from 1,000 to 2,000

Fig. 1214.



Centrifugal Machine.

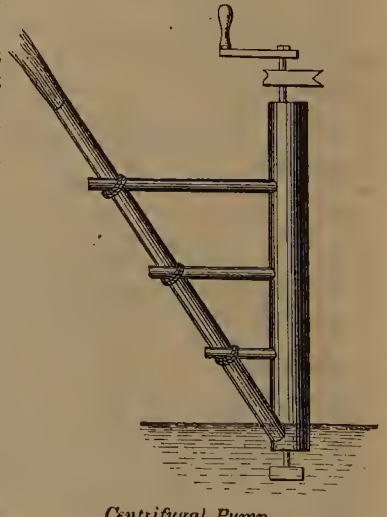
revolutions per minute, the water flies off by the centrifugal action, and is collected by the enclosing cylinder, down which it trickles to a discharge-pipe. It is also found useful in removing the must from the grape after crushing.

The illustration shows a machine with an inner cylinder *m*, and an outer one, both revolving in concert and driving outwardly to the chamber *A* the molasses in the sugar, which surrounds the cone *B*.

Cen-trif'u-gal Pump. A rotary pump in which the fluid is driven outwardly from the center at which it is received, and diverted into an upward direction.

Le Demour's centrifugal pump (Fig. 1215) is supposed to have been the first of its kind. It is but a clumsy contrivance, viewed in the light of the more recent inventions, which are generally forms derived from the turbine.

Fig. 1215.

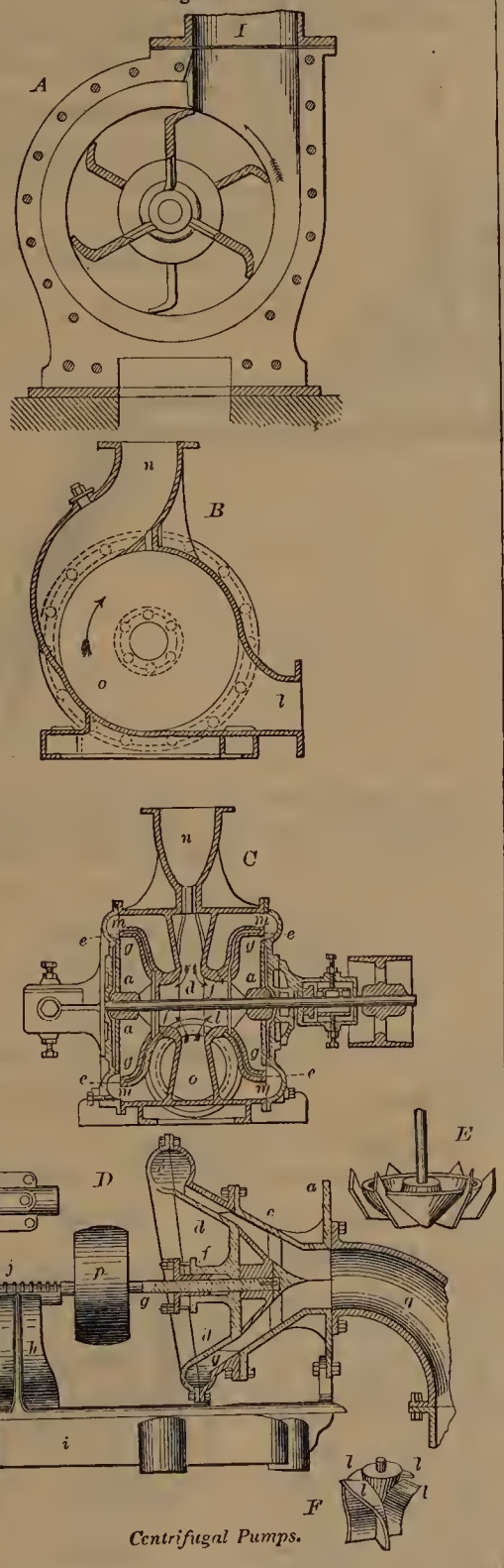


Centrifugal Pump.

They do for water what some forms of fan-blowers do for air, and are also much like many rotary engines in the construction of the parts, only the vanes of the rotary steam-engines are pressed by steam, while those of the centrifugal pump move against the water, and drive *it*. See also ROTARY PUMP.

In the *Konet en Letterbotte*, Haarlem, Hollaud, April 19, 1841, occurs a suggestion of P. H. Van der Weyde, for the use of a turbine-shaped wheel as a centrifugal pump, the process being inverted so

Fig. 1216.



Centrifugal Pumps.

"that, in place of obtaining power by means of descending water, we may raise water by applying a given power." The centrifugal pump known as the "Gwynne" pump was used by Andrews and Brother in New York in 1844.

In Fig. 1216 are shown several forms of the centrifugal pump, differing more in detail and proportion than in principle.

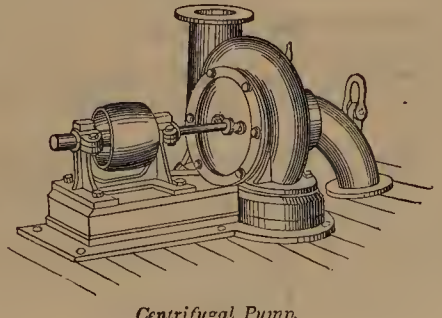
A shows Gwynne's centrifugal pump, which has six equidistant pallets inclined backwardly toward their outer extremities. Three of these extend from the axis, and the remainder only from the margin of the annular induction-space around the axis. The wheel rotates in a shell in the direction of the arrow, and delivers the water upward into the eduction-pipe *L*.

Girard's turbine elevator resembles five distinct turbines on a vertical axis, one above another, each taking the water from the one below it, and delivering it in turn to the one above it.

B C shows the Coignard centrifugal pump, as shown at the French Exposition, 1862. A vertical section across the axis of one of these pumps is shown at *B* (Fig. 1216) and another section, also vertical, through the axis, at *C* (same figure). Here there are two revolving-drums, *g a*, *g a*, both attached to the same axis *d*. They revolve in water-tight boxes, but the entrance of the water takes place from the space *o*, between the drums; the openings for admission being at *f*. The discharge takes place through an annular lateral space *e e e e*, into an annular cavity *m m*, which conducts it to the rising tube *n*. The tube of aspiration is *l*, which communicates with the space between the drums *o*. The form given to the pallets in this machine is spiral; they are only two in number in each drum. As in the other pumps, the form of the helices is professedly such as to make the section of passage inversely proportional to the velocity of the water at different distances from the center.

Andrews's centrifugal pump (*D*, Fig. 1216) resembles a helix or snail's shell, which forms the base of a double cone placed with its axis in a horizontal position, the space between the inner and outer cones being the chamber of the pump, and occupied by a kind of turbine-wheel shown in the detached view *E* (same figure). *F* is the stationary boss with spiral flanges *l*, which give the water a twist just as it enters upon the action of the wheel, which has six vanes, as seen in the view *E*. *a* is the base of the pump, cast in one piece with the case *c*, to which is attached by flanges the conducting-case, composed of two parts *d d'*, forming a spiral discharge-passage *g* and *e*; gradually enlarging to the outlet *f* is the stuffing-box, through which passes the driving-shaft *g*; this having turned in its surface at *j*, a series of grooves, which are accurately fitted in a Babbitt metal-box in the standard *h*, counteracting any tendency to end-thrust or vibration. *i* is the bed-plate, having cast upon it the standard *h*, and brackets to which the pump is secured by the flanges and base. When required to be run vertically, no bed-plate is used, but the pump is secured by the base. The base also forms a flange, to which

Fig. 1217.



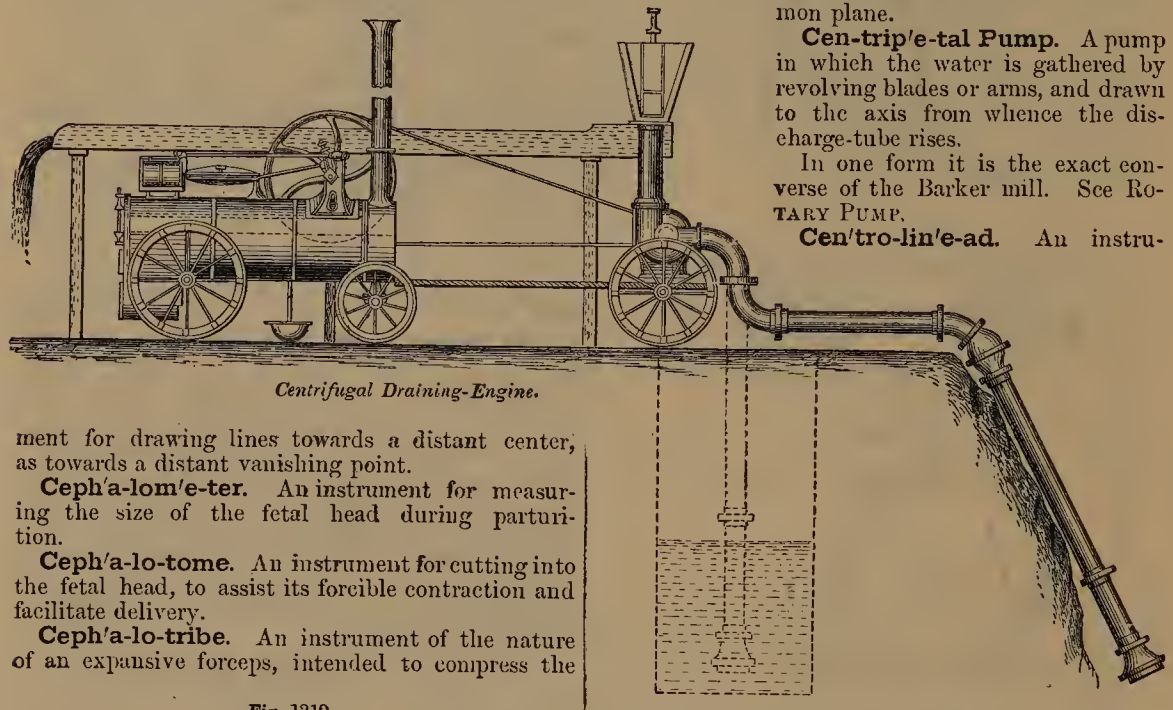
Centrifugal Pump.

is bolted the bend *q* of the suction-pipe, which has a foot-valve at its lower end. Motion is communicated by a belt upon the pulley *p*.

Fig. 1217 gives an exterior view of a centrifugal pump.

Fig. 1218 shows the centrifugal pump, with portable engine connected, as arranged for pumping out a pond, or pumping from a river with a shelving bank, the dotted lines showing it as adapted for pumping out of a cistern or well. The pump is placed upon a two-wheeled carriage firmly attached to the engine when working, and driven by a band from the fly-wheel of the engine.

Fig. 1218



Centrifugal Draining-Engine.

Cen-trip'e-tal Press. A mechanical contrivance for pressing inwardly on a radial line from all directions in the common plane.

Cen-trip'e-tal Pump. A pump in which the water is gathered by revolving blades or arms, and drawn to the axis from whence the discharge-tube rises.

In one form it is the exact converse of the Barker mill. See ROTARY PUMP.

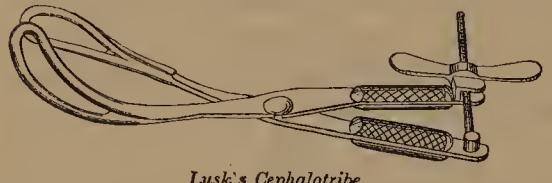
Cen'tro-lin'e-ad. An instrument for drawing lines towards a distant center, as towards a distant vanishing point.

Ceph'a-lom'e-ter. An instrument for measuring the size of the fetal head during parturition.

Ceph'a-lo-tome. An instrument for cutting into the fetal head, to assist its forcible contraction and facilitate delivery.

Ceph'a-lo-tribe. An instrument of the nature of an expansive forceps, intended to compress the

Fig. 1219.



Lusk's Cephalotribe.

fetal head and facilitate delivery. It has to a considerable extent superseded the *crochet* and *perforator*.

The instrument depicted has blades with a cephalic curve, which gives it power as a compressor, and grasp as a tractor.

Ce-ram'ics. All varieties of work formed of clay, in whole or in part, and baked, are included under this name. See BRICK; TILE; ENAMEL. See also specific list under POTTERY AND CLAY.

It is distinguished from *vitrics*, in which silex predominates, the result being glass.

Ce'ra-to-tome. A knife used in dividing the cornea.

Ce-rau'no-scope. An instrument to imitate lightning and thunder.

Cere-cloth. Waxed cloth; formerly used as a shroud in embalming. Hence *cerements*. See EMBALMING.

Cer'iph. (*Printing.*) The fine lines of a type or letter at the top and bottom, projecting beyond the heavy strokes. The terminal cross-lines of a letter. Also called hair-lines.

Ce'ri-um. A heavy, grayish-white metal, but little known or used.

Ce'ro-graph. A writing on wax.

Cer'vix-di-la'tor. An instrument which is used for dilating the cervix uteri when contracted, particularly the internal os. After the point is thrust in,

Fig. 1220.

Cervix-Dilator.

the handles are pressed together, which expands the blades.

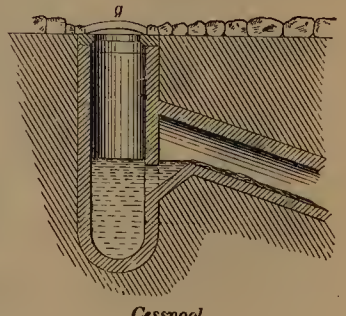
Cess-pipe. A pipe for carrying off waste water, etc., from a sink or cesspool.

Cess-pool. 1. A privy-vault.

2. A cistern to collect sedimentary matter passing into drains.

The washings of the streets contain much gravelly and sandy *débris*, and during rain-storms other articles are carried through the open or grated entrance *g* to the sewers. Such things are collected in the cistern or cesspool, and the water flows off beneath the trap-wall, which prevents the upward passage of mephitic air and gases. See CATCH-BASIN.

Fig. 1221.



Cesspool.

Chaf'er. A small portable furnace. *Chaffer*, *chauffer*.

Chaf'er-y. A forge in an iron-mill, wherein the iron is wrought into bars.

Chaff-cut'ter. A machine for chopping or cutting long feed, such as hay, straw, or stalks, into chaff, in which condition it may be fed in a box or bag, dusted with bran or meal. An economical and compact mode of feeding. See STRAW-CUTTER.

Chaff-halt'er. A lady's bridle with double reins.

Chaf'ing-dish. 1. A pan of coals to heat a dish. 2. A dish heated by lamp or jet beneath.

Chaf'ing-gear. (*Nautical.*) *Parceling* or *serving* on ropes, to keep them from being chafed by running rigging.

Chain. 1. A device consisting of several associated links, joined endways so as to string out in line.

The varieties of chains are numerous, and their names are derived from their (*a*) material, (*b*) structure, or (*c*) purpose, as, —

a. Gold, steel, galvanized iron, etc.

b. Twisted link, flat link, etc.

c. Top-chain, curb-chain, surveyor's chain, mooring-chain, etc.

Chains in olden times had three purposes.

(1.) They were worn as emblems of investiture or badges of office, as in the cases of Joseph and Daniel, in Egypt and Babylon. The idea was preserved in Persia, and blossoms yearly in the civic ceremonies wherein London rejoices that she has found another mayor.

(2.) For ornament. Necklaces, girdles, and ankle-chains were used by various nations of antiquity. Jewels were worked into the links or strung upon cords. To the chains which hung from the neck, fancy or fashion suspended cowries, mirrors, "round tires like the moon," trinkets, amulets, emblems, and scent-bottles. The Midianites, who invaded Palestine in the time of Gideon, ornamented with chains the necks of their camels. The modern uses of ornamental chains are numerous and familiar.

(3.) For confining prisoners. Before and after the time when poor Samson was blinded and then bound with fetters of brass, when David lamented Abner, and the fugitive Jedekiah, after defending his capital for two years, became a fugitive, was captured, blinded, bound with chains of brass, and carried to Babylon, chains, fetters, and manacles were the lot of captives and criminals. Peter slept "between two soldiers bound with two chains," being, no doubt, handcuffed to his guards on either side. Herod, of course, had the soldiers killed, which was the ordinary punishment of a Roman guard who allowed his prisoners to escape.

The Romans used chains with links of various patterns; circular, oval, figure-8, horse-shoe, bars with eyes, etc. These were principally of a small size and ornamental character. Their cable was of rope, as it was with us until a few decades since. Xerxes thrashed the Hellespont with chains, and then threw chains into the strait as a reminder; but the bridge he built was of rope, supported by ships, and sustaining the planks on which the host crossed.

Twisted chains are mentioned by the Greek authors.

Iron for chains is cut off with a plain chamferer; each piece is then bent, introduced, and welded. In common chains the weld is made at the small end, called the *crown*.

In chain cables the weld is at the side of the oval, the *scarf* being flatways of the link. The parts and consecutive forms are shown at *i*, *j*, *k* (Fig. 1222).

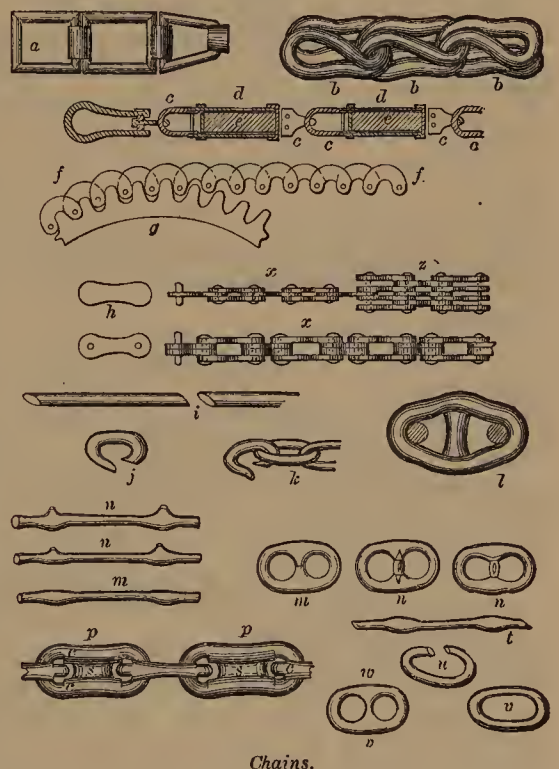
Curbed or twisted chains are welded in the ordinary manner and twisted afterwards; each link as it is welded, or a few made hot at a time and twisted.

Chains with flat links are made in the fly-press. The links are cut out, of the form shown at *h*. The holes are afterwards punched as in washers, one at a time, every blank being so held that its circular extremity touches the stops on the bed or die, which insure the centrality of the blank and punch. The two holes are thus made equidistant in all the links, and are afterwards strung together by inserting wire rivets through the holes.

The pins or rivets for the links are cut off from the length of wire in the fly-press, by a pair of cutters like wide chisels with square edges, assisted by a stop to keep the pins of one length; or by one straight cutter and an angular cutter hollowed to about 60°, or by two cutters, each hollowed to 90°. In the three cases, the wire is respectively cut from two, three, or four equidistant parts of its circumference.

Sometimes the succession of the links of the chain is one and two links alternately, as at *x*; or three and two, or four and three, as at *z*, up to eight and nine links, which is sometimes used. The wires when inserted are slightly riveted at the ends.

Fig. 1222.



Chains.

Chains intended to catch on pins or projections on the periphery of a wheel are made two and two, as in the other figure, leaving an opening which slips over the cog.

Mr. Oldham, the engineer to the Bank of England, contrived a curved link-chain *f f*, adapted to work in connection with a cog-wheel *g*, with epicycloidal teeth.

Chains for watches, timepieces, and small machinery are too minute to be made as the ordinary flat-link chain. The slip of steel is first punched through with the rivet-holes for a number of links, by means of a punch in which two steel wires are inserted; the distance between the intended links is obtained (somewhat as in file-cutting) by resting the

burrs of the two previous holes against the sharp edge of the bolster. The links are afterwards cut out by a punch and bolster of a minute size. The punch has two pins inserted at the distance of the rivet-holes; the slip of steel being every time fitted by two of the holes to these pins, all the links are thereby cut centrally around these rivet-holes.

The tools are carried in a thick block having a perpendicular square hole, fitted with a stout square bar; the latter is driven with a hammer, which is supported by pivots raised by a spring and worked by a pedal. When the links measure from $\frac{1}{4}$ to $\frac{1}{2}$ inch in length, the press is worked by a screw.

The punches are fitted to the side of the square bar, in a projecting loop or mortise, and are secured by a wedge. They are drilled with holes for pins, and across each punch there is a deep notch to expose the reverse ends of the pins, in order that, when broken, they may be driven out and replaced. The pins are taper-pointed, that they may raise burrs, instead of cutting the metal clean out; and, being taper, no puller-off is required, and the bed-tools are fitted in chamfer-grooves in the base of the instrument.

A pocket chronometer-chain 14 inches in length, containing in every inch of its length 22 rivets and 33 links, in 3 rows, has 770 pieces, and weighs $9\frac{1}{2}$ grains.

A chain for a small pocket-watch measures 6 inches in length, has 42 rivets and 63 links in every inch, in all 630 pieces; and the whole chain weighs $1\frac{3}{4}$ grains.

Chains for jewelry are cut with punches. The exterior and interior of each is frequently rectangular; each alternate link is slit with a fine saw for the introduction of two contiguous links, and the slit is soldered up.

Rigging-chain is usually of the open-linked kind, with oval links. It is described by stating the diameter of the rod of which the links are made.

The outside breadth of a chain is about $3\frac{1}{2}$ times the diameter of the rod of which it is made.

a a (Fig. 1222) is an open-linked chain with thimbles for the engagement of the pins of a sprocket-wheel in water-elevators.

b b are the links of a chain of bent loops made without cutting or welding.

c c are the links of an elastic chain, in which blocks of india-rubber are so placed as to be compressed by a pull on the chain.

m n n are forms of Acraman's chain, 1820, in which the bar is rolled with protuberances which form by mutual contact an actual stay, or form sockets for stay-pins.

p p are links of Sowerby's chain-cable, 1822, which are bent inward at the middle, where they are stayed by a block *s*, secured by a riveted pin. The projections *c c* are to prevent entanglement of the links.

HAWKS's English patent, 1828, has links made of iron rolled with enlargements which correspond to the ends of the links where the greatest amount of friction occurs.

The illustration shows —

A *link-blank*, *t*, the edges cut off with a *scarf*.

The link bent, *u*.

Welded, *v*. Stayed, *w*.

2. The surveyor's chain (Gunter's) has 100 links, each of which is $7\frac{92}{100}$ inches in length; the whole measuring 4 rods, equal to 66 feet. See SURVEYOR'S CHAIN.

3. (*Weaving.*) The *warp*-threads of a *web*. Also known as the *chain*, *filling*, or *twist*; and in silk as *organzine*.

Chain-belt. A chain forming a band or belt for the conveyance of power.

Fig. 1223.

Chain-Belt.

A chain covered with piping or overlaid with strips to form a round belt.

Chain-boat. A substantial boat used in harbors in recovering chain-cables and anchors.

Chain-bolt. 1. (*Shipbuilding.*) A bolt to secure the chains of the dead-eyes through the toe-link as a fastening for the shrouds.

One of the bolts fastening the channel-plate to the ship's side.

2. One having an attached chain by which it may be drawn back, falling by its own gravity or pushed into place by a spring. Used with high doors of rooms or book-cases.

Chain-bridge. 1. A form of ferry-bridge in which the passage is made by chains laid across the river and anchored on each side, and moving over chain-wheels on board, driven by engines. Such a ferry-bridge used to cross the Itchen River, Hampshire, England. The chain pier of Brighton was erected in 1822. The chains of Hungerford Bridge, London, were moved to Clifton, near Bristol, and now span the Avon. The span is 720 feet; hight above water, 260 feet. See FERRY-BRIDGE.

2. An early (for Europe) form of the suspension-bridge in which catenary chains supported the floor. The first was erected over the Tees, in England, in 1741. Rods with eyes and connecting-links were used by Telford on the Menai Suspension Bridge, 1829; steel wires laid up (not twisted) into cables are now used. See SUSPENSION-BRIDGE; FRONTISPIECE.

Chain-bond. The tying together of parts of a stone-wall by a chain or iron bar built in.

Chain-ca'ble. (*Nautical.*) A chain adapted to use as a cable in holding a ship to its moorings or anchor.

The ancient Greeks used rushes; the Carthaginians the *spartium* or broom of Spain and Libya (Africa); the Egyptians, papyrus.

The ancient maritime people, the Veneti, used iron chain-cable for their ships in the time of Julius Cæsar.

In the tenth century the nations of the Baltic used ropes of twisted rawhide thongs. The latter were used in Britain till the third century, and are yet used in Western Scotland for boats and draft.

Chain-cables were used by the Britons. (CÆSAR.) They were common long ago in small sizes, but were only lately made for heavy craft.

They have shackles at every 15 fathoms, sometimes swivels at $7\frac{1}{2}$ fathoms.

Chain-cables were made in England by machinery in 1792, and introduced into the British merchant-service by Captain Brown of the "Penelope," West India merchantman, 400 tons burden, 1811. The cable had twisted links.

BRUNTON patented the stay in the middle of the link. See CHAIN.

The chain-cable was introduced into the British navy in 1812.

In making chain-cables, the bar of 1, $1\frac{1}{2}$, or 2 inch iron is heated, and the scarf is made by a cutting-

machine ; an oblique cut on the end of the rod, giving a *chamfer* or lap to the cut surfaces, brings a larger surface of the iron into welding contact. The link is formed by inserting the end of the heated bar within a loop in the edge of an oval disk, which may be compared to a chuck, fixed on the end of a lathe-mandrel. The disk is rotated by steam-power, and makes exactly one revolution, when it throws itself out of gear. The heated end of the iron rod thus receives an oval loop, which is detached from the rod by a *chamfered* or oblique cut, making the second scarf for the link and the first scarf for the next link. The link is now concatenated, closed together, and transferred to the fire, the loose end being carried by a traverse chain. When properly heated, it is transferred to the anvil, welded and dressed off between top and bottom tools, after which the cast-iron transverse stay is inserted and the link closed thereupon.

Chain-cables are generally made in lengths of from 12½ to 25 fathoms ; each length is usually provided with a *swivel*. The lengths are joined together by *shackles* (which see).

A cable's-length is 100 fathoms of 6.08 feet each, and is one tenth of a nautical mile.

Chain-cables are stowed in chain-lockers, generally near the mainmast, or just before the engine and boiler compartment. The locker-space required may be found by the following rule : Multiply the square of the diameter of the cable-iron in inches by 35. The product is the space required in cubic feet, nearly.

Four kinds of apparatus are used for regulating or checking the motion of the cable as it runs towards the *hawse-holes;* and for holding on by the cable after the anchor has taken hold.

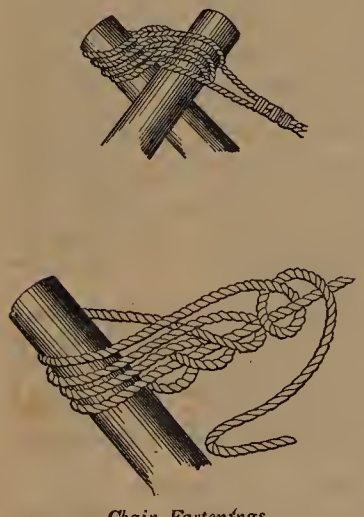
These are CONTROLLERS ; BITTS ; STOPPERS ; COMPRESSORS (which see).

Chain-coup'ling. (*Railroad Engineering.*) 1. A supplementary coupling between cars, as a safety-device in case of accidental uncoupling of the prime connector.

2. A shackle for a chain whereby lengths are united as in a chain-cable, or a shackle or clevis to unite a chain with an object.

Chain-fast'en-ing. A sailor's bend, or cable mooring. The upper figure shows the *double* chain-fastening ; the lower one the *single* chain-fastening.

Fig. 1224.



Chain-Fastenings.

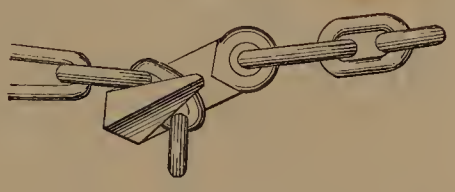
Chain-gear. A form of cog-gearing in which an open linked chain catches up the cogs or sprockets of the wheel, and is the means of motion thereof, or conversely. See CHAIN-WHEEL.

Chain-guard. (*Horology.*) A mechanism in watches provided with a fusee, to prevent the watch being overwound.

Chain, Gun'ter's. The surveyor's chain, having 100 links, each $7\frac{92}{100}$ inches in length ; total length 4 rods, equal to 66 feet. See SURVEYOR'S CHAIN.

Chain-hook. (*Nautical.*) 1. An iron rod with a handling eye at one end and a hook at the other for handling the chain-cable.

Fig. 1225

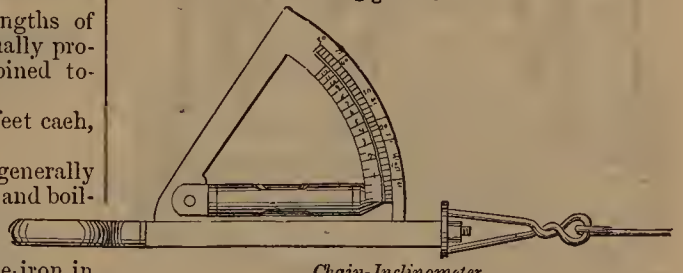


Chain-Hook.

2. A cable-stopper which clamps the link of a chain between two other links, as in Fig. 1225.

Chain-in'cli-nom'e-ter. A form of level in which the inclination of the surveyor's chain is indicated on a scale by the pointer on the end of the level.

Fig. 1226.



Chain-Inclinometer.

Chain-knot. 1. A succession of loops on a cord, each loop in succession locking the one above it, and the last one locked by passing through it the end of the cord.

2. A kind of knot used in splicing. See KNOT.

3. The loop-stitch of some sewing-machines. See STITCH.

Chain-lift'er. (*Nautical.*) A cast-iron grooved rim, with projections, situated at the foot of the capstan-barrel, and forming the drum around which the chain-cable is wound in weighing anchor.

Chain-lock'er Pipe. (*Nautical.*) The iron-bound opening or section of pipe passing through the deck, and through which the chain-cable passes to or from the locker in which it is stowed.

Chain of Locks. (*Hydraulic Engineering.*) A succession of lock-chambers, the lower pair of gates of each of which (except the lowest) forms the upper pair of gates for the chamber below. See CANAL-LOCK.

Chain-pin. (*Surveying.*) The wire pin, having a loop at one end and pointed at the other, employed by surveyors for marking the termination of each chain in measuring distances.

Chain-plate. (*Shipbuilding.*) One of the plates of iron bolted below the *channels*, and serving for the attachment of the dead-eyes to which the shrouds and back-stays are secured.

Fig. 1227.

Chain-Pulley.

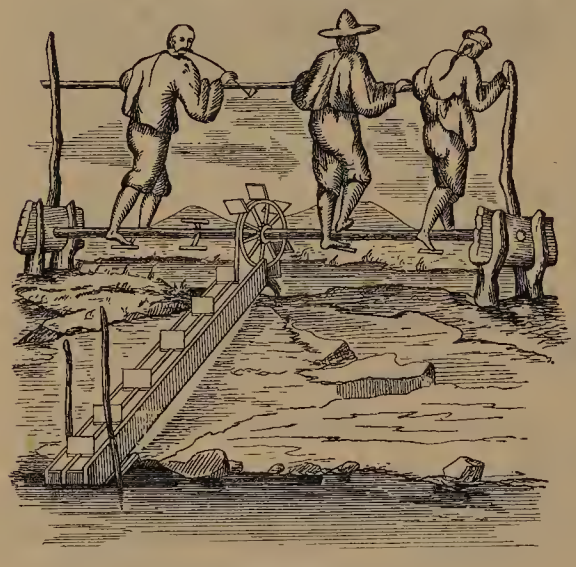
Chain-pul'ley. One having pockets or depressions in its periphery, in which lie the links, or alternate links, of a chain which passes over it and gives motion thereto, or conversely.

Chain-pump. One form of the *chain-pump* consists of an endless chain passing around a wheel above and descending into the water below.

In its upward course it passes through a vertical tube whose lower end is submerged, and at whose upper end the water is discharged. Along the chain are round disks or buttons, which fit in the bore of the tube, and form pistons which elevate the water as the chain ascends in the tube. The cellular pumps are of this kind, and when packed pistons are used, they are termed *paternoster pumps*, from the resemblance of the chain and buttons to the rosary.

The chain-pump is a common irrigating-device in China. The barrel is turned by men by means of a treadmill, or by a buffalo, which rotates a large horizontal wheel connected by cogs with the axis of the roller over which the chain runs. The chute is inclined, and the buckets are square boards attached at intervals along the chain. Small machines are turned by hand in the manner of a grindstone, a plan so familiar in our ordinary chain-pumps.

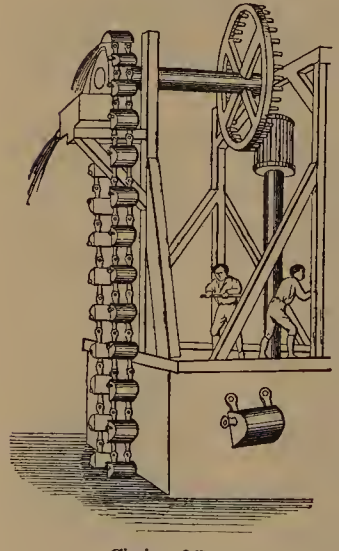
Fig. 1228.



Chinese Chain-Pump.

The chain-pump is sometimes called the *Spanish noria*, but improperly. The *Spanish noria* has a pair of chains or ropes between which buckets or pots are secured, dipping water at the bottom and discharging at the top. They have no pistons or ascension-tube, but are like one very common form of the noria of Palestine. The rope of the latter, however, owing to the poverty of the people, is made of withes of myrtle branches.

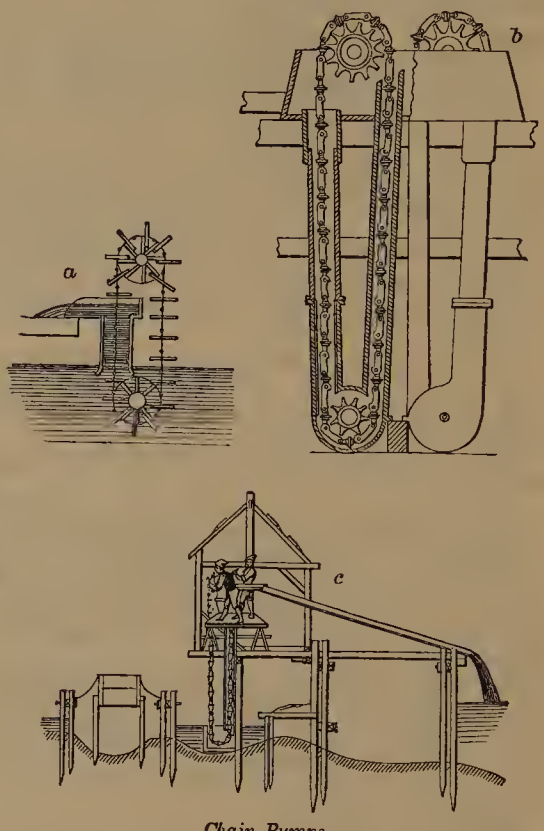
Fig. 1229.



Chain of Pots.

The familiar domestic chain-pump (*a*, Fig. 1230) acts by continuous rotation of a crank. The disks on the chain fit as nearly as may be in the stock which they ascend, and thus lift the water in a continuous stream. In practice, these disks are like buttons, and form links in the chain, which is galvanized to prevent rusting. The tubing is made of some light

Fig. 1230.



Chain-Pumps.

wood and in two longitudinal pieces, the hollow being cut half in each piece, and the sections nailed or bound together.

The axis of one wheel is supported on the curb, and the other on a post in the bottom of the well, or on a scantling lowered from above.

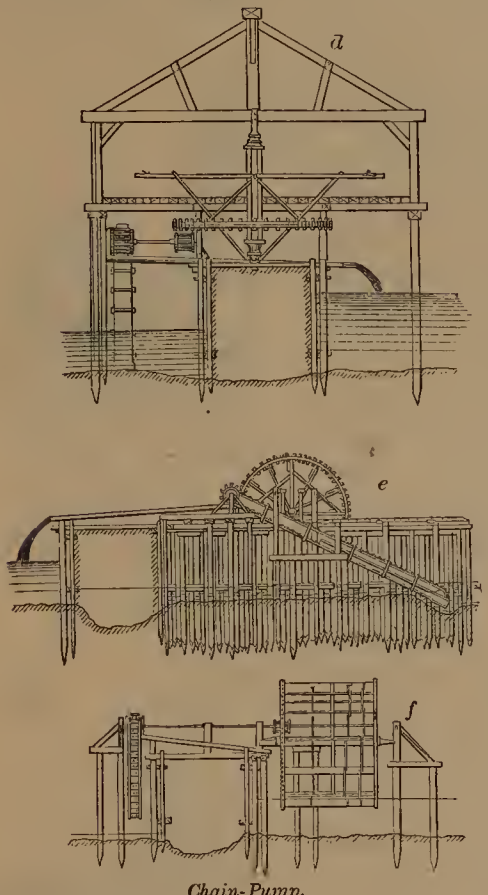
The chain-pump *b* was first used in the British navy on board the "Flora," in 1787. As now used in the English navy, it is formed of a long chain which carries disks at intervals, and passes over sprocket-wheels above and below; the chain passes down a tube called the back-casing, dips into the limber where the bilge-water collects, and up through another tube at whose summit is a cistern. The upper sprocket is turned by a crank, and the tube is made of wood lined with brass. The links are of iron, and each piston consists of two circular brass plates inclosing disks of leather. The upper delivery is into a pump-dale, which conducts the water over the side of the ship.

The *chain-pumps* (*chapelets*) used by the architect Perronet, to drain the coffer-dams of his bridges at Orleans and elsewhere, were worked by manual, horse, and water power, and are described in Cresy's Encyclopædia of Civil Engineering. The bucket-wheel he used at the bridge of Neuilly is described under NORIA.

The tube of the hand-worked chapelet *c* was vertical, 12 to 18 feet in length, 6 inches in diameter. Four men worked the winches, and were relieved every two hours. They made from twenty to thirty turns in a minute, according to the depth; 500 cubic feet of water were raised per hour, 4½ feet of the chain being wound round at each revolution.

Another of Perronet's chain-pumps (*d*), used at the bridge of Orleans, was worked by horse-power, twelve at a time being employed, and making 140

Fig. 1231.



Chain-Pump.

turns per hour. The pallets acted as buckets, and passed at the rate of 9,660 per hour.

The same master-wheel drove two separate chapelets, with the power above stated; the duty referred to being accomplished by each.

e is a section, and *f* an elevation, of another of Perronet's chapelets driven by a water-wheel.

Chains. (*Nautical.*) Iron bars bolted to the sides of the vessel and holding the *dead-eyes*, to which the lower ends of the shrouds are connected.

Top-chains are sling-chains for the lower yards.

Chain-saw. 1. (*Surgery.*) A saw whose teeth are jointed links, used in making sections in deep-seated places by passing the saw around the bone and then back again, so as to give command of both ends to the operator, who draws the ends back and forth.

Fig. 1232.

Chain-Saw Carrier

2. One form of band-saw or scroll-saw is also made of separate teeth pivoted or hooked together.

Chain-saw Car'rier. (*Surgery.*) A hinged and hooked instrument whereby the end of the chain-saw, or a ligature, by which the saw may be drawn, is passed beneath a deep-seated bone, and so far up on the other side as to be grasped by a forceps.

Chain-shot. A shot formed of two hemispheres or spheres connected by a chain. Invented by Admiral DeWitt, 1666. Formerly much employed for carrying away rigging in naval actions. They were sometimes fired from a cannon with two slightly diverging barrels, united at the breech, forming a single chamber, and discharged through a single vent.

Chain-stitch. 1. An ornamental stitch resembling a chain.

2. (In sewing-machines.) A *loop*-stitch in contradistinction to a *lock*-stitch. It consists in looping the upper thread into itself, on the under side of the goods; or using a second thread to engage the loop of the upper thread.

The *double-chain* stitch of the Grover and Baker machine is made by a lower thread which engages two loops of the upper thread.

One form of the Wilcox and Gibbs machine makes a double-loop engagement with but a single thread. See STITCH.

Chain-stop'per. (*Nautical.*) A clamp or compressor to keep a cable from veering away too fast, or to lock it.

Chain-tim'ber. 1. A timber of large dimensions placed in the middle of the hight of a story, for imparting strength.

2. A bond timber in a wall.

Chain-tow'ing. A plan for canal-boat propulsion. A chain or wire rope, five eighths of an inch in diameter, is laid on the bottom of the water-course, but passes longitudinally over the deck of the boat to be drawn. It there winds upon or around a wheel, or clip-drum, five feet in diameter, the revolutions of which draw the boat by a pull upon the chain, this being lifted at the bow and let down at the stern of the vessel as the latter progresses. The free movement of the chain is provided for by making the two ends of the boat quite low, sloping nearly to the water, while the center, where the drum is situated, is elevated to a considerable hight. The motive-power is supplied by a steam-engine moving its crank-shaft, connected with the axle of the drum by suitable spur-gearing.

The chain system is now in use on the Danube, on the Charleroi Canal, in Belgium, the Beveland Canal, in Holland, and the Terneugen Canal, connecting Ghent with the Scheldt. It is about to be adopted on the Rhine, to facilitate the passage of Bingen Rapids, and on the Upper Elbe.

The chain-towing system was first tried in France in 1732 by Marshal Saxe, in transporting war-material. One end of the rope was fastened at a point in advance, and the other passed round the drum of a horse-windlass on board the boat. When the fast end of the rope was reached, the boat was moored until the rope was adjusted for another pull. Nearly a century after this — in 1820 — a modification of the plan was put in regular use on the Rhone. The boat carried a steam-capstan arranged to wind alternately two ropes. Two tenders were provided to accompany the boat. The capstan, winding one rope as in the former case, drew the boat forward and at the same time unwound the other rope upon one of the steamers, which, moving in advance, fixed it for being wound in its turn as soon as the end of the other was reached.

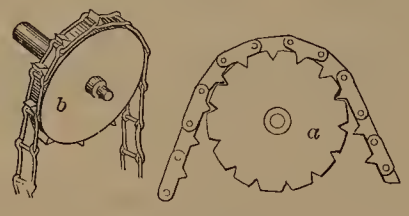
The grand points to be reached by this device are to avail steam as a motor and save the necessity of tow-paths. Modifications of the system have long been in use on our western rivers, and they are navigated successfully by a wire rope which passes over a drum, and is payed out over the stern, as just stated. See TOWING.

Chain-wales. (*Shipbuilding.*) One of the *wales*

or thick planks bolted to the ship's sides and serving for the attachment of the *chains* to which the shrouds are connected. *Channel.*

Chain-wheel. The sprockets on the wheel are adapted to receive the links of the chain successively.

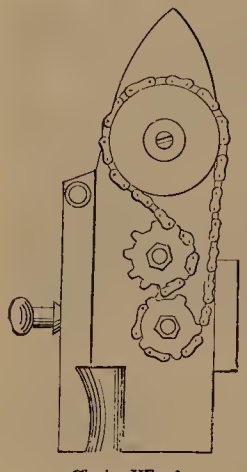
Fig. 1233.



Chain-Wheel.

The power may be communicated by the wheel to the chain, or conversely. The former is shown in the familiar chain-pump, and the latter in machines where the operation is inverted; the column of water pressing upon the buttons attached to the chain and causing them to descend in the tube, thereby rotating the wheel.

Fig. 1234.



Chain-Wheel.

De Vaucauson's chain-pulley was notched on its perimeter and worked in connection with a chain having toothed links.

Another form (*b*) is an open-linked chain acting in connection with a *pin-wheel* or *sprocket-wheel.*

Fig. 1234 shows the application of a chain to driving several wheels in different directions.

Chain-work. A style of textile fabric consisting of a succession of loops, and including hosiery and tambour-work.

Chair. 1. A movable seat provided with a back and adapted for one person.

The names of chairs depend upon structure, material, and purpose: —

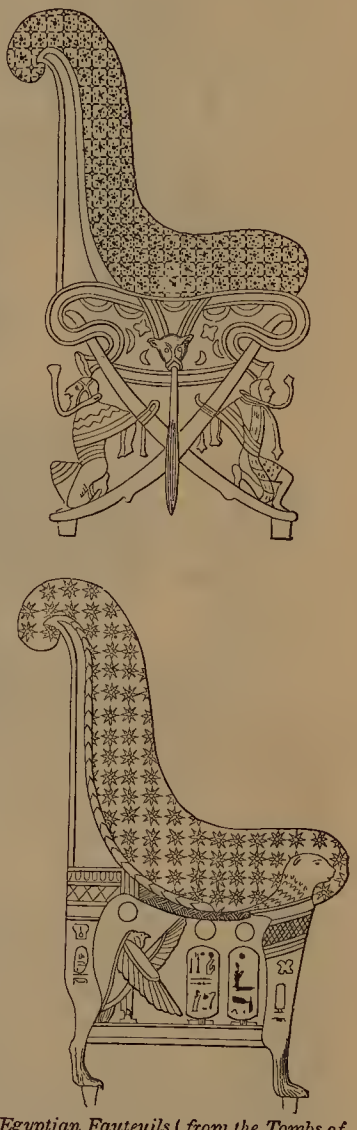
Barber's-chair.	Pew-chair.
Bath-chair.	Photographic-chair.
Camp-chair.	Railway-chair.
Dentist's-chair.	Reclining-chair.
Enema-chair.	Revolving-chair.
Folding-chair.	Rocking-chair.
Invalid-chair.	Sedan-chair.
Locomotion-chair.	Sleeping-chair.
Metallic-chair.	Surgeon's-chair.
Nursery-chair.	Tailor's-chair.
Obstetrical-chair.	Travelling-chair.
Office-chair.	Wire-chair.

Several of which are considered under their alphabetical heads.

The Egyptians were probably among the first people to make chairs. The originality and taste of this grand nation were stupendous and glorious. On the tombs at Thebes, Alabastron, and elsewhere, but especially the former, are found chairs of almost all kinds which modern ingenuity has revived. Thrones, couches, sociables, folding, reclining, lazy-back; leather-seated, cane-seated, split-bottom, made of ebony, inlaid with metals and ivory, with carved backs, sides, and legs; with claw-feet and foot-pads, and upholstered with gorgeous coverings resembling the rich stuffs of modern luxury.

Fig. 1235 shows how little in the way of luxury was left to be desired in the chair line. The back consisted of a frame, receding gradually and terminating at its summit in a graceful curve supported from without by perpendicular bars. Over the chair was placed a handsome pillow of colored linen or wool, painted leather, or gold and silver tissue. The upper figure has an elaborately carved frame, the legs of which are formed of crossed swords, to which are tied captive figures of different nationalities. The brutal mode of tying was common among this people, as may be seen by looking at the drawings in Champollion, Roselline, Lepsius, and the "Description de l'Egypte." The original colors of the chair-frames are blue and gold and red and gold respectively; of the upholstery, red and gold and blue and gold.

Fig. 1235.



Egyptian Fauteuils (from the Tombs of the Kings), Thebes, Africa, 1500 B. C.

Du Chaillu describes the easy-chair of Obindji, a chieftain of the Ovenga River, in the Gaboon country, Africa. The Ovenga is the name given to the river Fernand Vas, above Goombi, and was traversed by the enterprising traveler Paul B. Du Chaillu, who walked in the land of the Gorillas a distance of 8,000

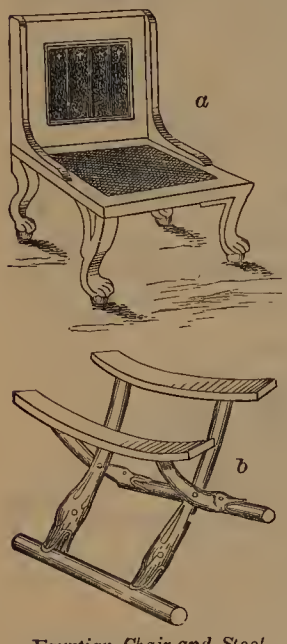
Fig. 1236.

Obindji in his Easy-Chair; Gaboon, Africa, A. D. 1873.

miles; shot, stuffed, and brought home 2,000 birds, killed 1,000 quadrupeds, bringing home 80 skeletons and 200 stuffed skins. As an interesting item having no relevance to the subject of chairs, it may be mentioned that he took over fourteen ounces of quinine in curing himself of fifty attacks of African fever.

The Egyptians were an Asiatic race, and it may be assumed, both from the probabilities of the case and from the frequency of the squatting posture in their paintings and bas-reliefs, that the introduction of the chair came in the progress of refinement.

Fig 1237.



Egyptian Chair and Stool.

In Fig. 1237, *a* represents a chair now in the museum of Leyden. The back and legs are of wood, the seat has a wooden frame and interlacing leathern thongs. The seat is only 13 inches high. In some, the interlaced material is cord. Beneath the feet are blocks or pads, probably to prevent noise in moving the chair on a marble floor.

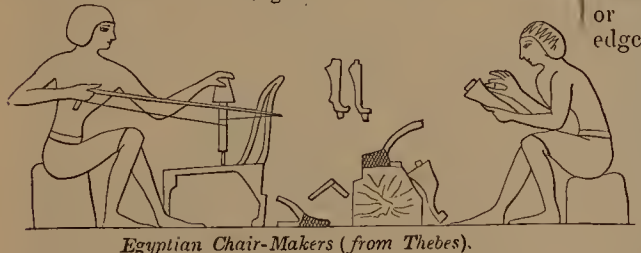
b is a stool made on the principle of our camp-stools. It is in the collection of Mr. Salt, and probably had a leather or leopard-skin cover. The same collection has an ebony stool, inlaid with ivory. The cushion is of leather, and is ornamented.

Many other illustrations might be given, did room permit; but we must be content with referring the reader to Wilkinson's "Customs of the Ancient Egyptians," and to the magnificent work on Egypt, on which the labor and enthusiasm of the French *savans* was so liberally bestowed early in the present century. A copy is in the Congressional Library in Washington, and other copies are probably to be seen in some of the libraries in the large cities. It is an immense and voluminous work.

The elaborate chairs referred to are on plate 89, Vol. II. of the plates, "Description de l'Egypte."

In a tomb of the time of Thothmes III., the Pharaoh of the Exodus, 1490 B. C., is a painting showing a couple of carpenters at work making

Fig. 1238.



Egyptian Chair-Makers (from Thebes).

chairs. One of them is using a bow-drill to bore holes in the seat for the braces of the back-posts, and the other is engaged finishing a leg, scraping it with a plate or sharp instrument in a delicate manner, as the artist is careful to inform us by showing three fingers of the man's hand in a raised position. The tenon on the upper end of the chair-leg is clearly shown in the one he is holding, and also in the two against the wall and that leaning against the post. The artist has also introduced two adzes and a square. The blades of the adzes are lashed to the helve, as was usual with them. None of their axes, hatchets, or adzes had eyes, but the blades were secured by being partially inserted into the helve or stock, and fastened by pins or thongs, or both. In most cases the metal was bronze; in some it is shown to be iron or steel, being colored blue to indicate that metal, red representing bronze.

The Egyptian chairs and stools were from $10\frac{3}{4}$ to 28 inches high, — quite a range, but probably some were intended for the children, others to be used with footstools.

A four-legged stool, with a seat revolving on a bronze pivot, is preserved in the British Museum. The chair is inlaid with ivory, and the seat is of maroon-colored leather.

"Cambyses, in consequence of the venality of the judge, slew and flayed Sisamnes, and, cutting his skin into strips, stretched them across the seat of the throne whereon he was wont to sit when he heard causes. He then appointed Otanes, the son of Sisamnes, to be judge in his father's room, and bade him never forget in what way his seat was cushioned." — HERODOTUS, V. 25.

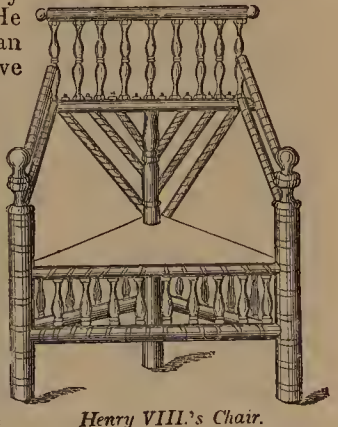
"The heroes of Homer sit at their banquets, and do not lie down. And this was the case at the feasts of Alexander the King, as Dures says. For he once, when giving a feast to his captains, to the number of 6,000, made them sit upon silver chairs and couches, having covered them with purple covers. And Hegesander says that it was not the custom for any one to lie down at a banquet, unless he had slain a boar which had escaped beyond the line of nets." — ATHENÆUS.

The fashion of reclining at banquets came from Persia.

"And what can for tired limbs compare
With the soft and yielding Thessalian chair?"
CRITIAS, quoted by Athenæus (A. D. 220.)

Fig. 1239 shows the chair of that "every inch a king" who was "Defender of the Faith" 350 years ago, and "Head of the Church" about thirteen years afterward. He did not suit everybody in either capacity. He was a better king than some better men have been.

Fig. 1239.



Henry VIII.'s Chair.

2. (*Railway.*) A foot-piece or base-plate for a railway-rail, by which it is secured to the sleeper or cross-tie. The edge-rail, as at first constructed, needed such a support to give it stability; the T-rail with a broad foot-flange may be spiked directly to the sleeper. See RAILWAY-CHAIR.

3. (*Vehicle.*) A kind of carriage. Originally a sedan; now a small carriage for a single person, an invalid. A *Bath*-chair.

Chair-back Ma-chine'. These machines may be band or jig-saws, which cut out the curved back-piece which is placed on the top of the pillars of the chair-back. Molding or rounding machines for chair-backs have a holder for the stuff, which is moved

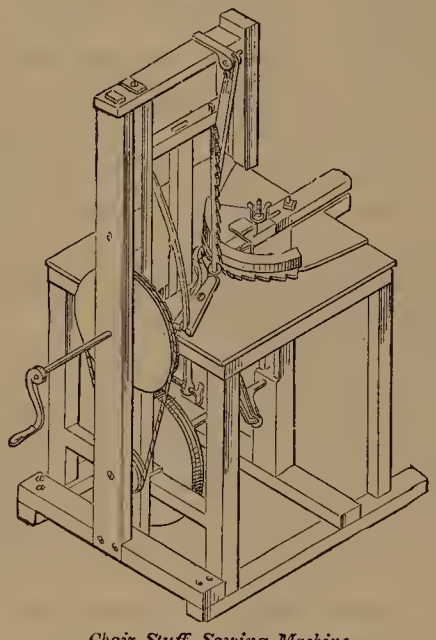
against a rotary cutter of peculiar shape, the stuff traveling in a prescribed path, so as to receive the conformation desired.

Scraping, dressing, and polishing machines for chair-backs are similar in their mode of presentation of the stuff, but differ in the character of the tool or appliance to which the work is presented.

Chair-bolt. A screw-bolt for fastening down rail-chairs to the sleepers.

Chair-mak'er's Saw. 1. A diminutive form of the ordinary frame-pit saw, in which the blade is

Fig. 1240.



Chair-Stuff Sawing-Machine.

strained by buckles and wedges. The work is clamped to the bench while sawing.

2. A scroll-saw especially adapted for getting out chair-stuff, such as backs and legs which have curves which cannot be readily bent, or of stuff which cannot be readily bent to shape.

Chair-or'gan. (*Music.*) A *choir*-organ placed in a separate case in front of the great organ and at the back of the performer.

Chair-seat Bor'ing-ma-chine'. Machine for the systematic and rapid boring of the small vertical holes in a chair-seat frame, to be occupied by the strips of cane or rattan, or the larger holes for the pillars and spindles of the back.

Chair-seat Ma-chine'. These include the planing-machines, by which the wooden bottoms of chairs are rounded out. The depth of penetration is governed by side guides, which raise and lower the bed relatively to the revolving cutter, or the latter relatively to the bed which carries the chair-seat. Lenman's machines for hollowing chair-seats have a pattern seat over which a governing ball is moved, determining the depth of penetration of the rotary cutter beneath, as it passes over the chair-seat stuff.

Machines are also constructed for cutting grooves in chair-seat frames for upholstering purposes, or to receive the chair-seat which is pressed into the frame.

Chair-spring. A spring underneath the hinged seat of a chair, which gives it a certain resilience, and encourages a tilting or rocking motion.

Springs are sometimes placed beneath the front legs to give a tilting motion.

Chair-web. A kind of saw. A scroll-saw.

Chaise. A vehicle with shafts and two high wheels, and a calash top. The body is supported by thorough-braces, and the elasticity resides in the long shafts and the bed-supporting bars which extend upwardly and backwardly therefrom. It is said that Augustus Imperator contrived this mode of hanging a carriage-body, and so was the inventor of the chaise. It is all the spring yet known to several kinds of Italian vehicles.

Chaise-cart. A light cart with springs, used in various light employment, where goods and parcels are to be expeditiously conveyed.

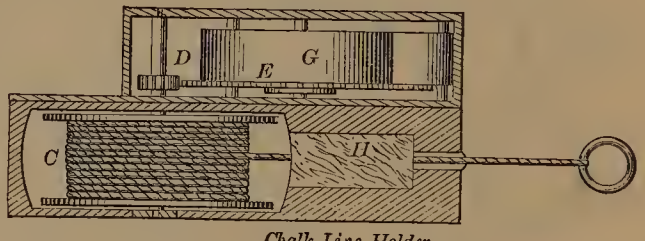
Chal'co-graph. An engraving on copper or brass.

Chal'ice. A cup. The drinking-vessel which holds the wine of the communion service.

Chalk-line. A cord rubbed with chalk or similar material, used by artificers for laying down straight lines on the material as a guide for a cutting instrument.

The Japanese use a wooden cup with a sponge saturated with india-ink, and having holes back and front through which the line passes. At one end of

Fig. 1241.



Chalk-Line Holder.

the line is a small awl, and this he sticks in the work at one end of the proposed line, then steps back and lets the line pay off the reel, passing through the ink in the cup. He then snaps the line, and walks back reeling up the line.

Somewhat similar is our chalk-line holder, in which the cord passes from the reel *C*, through the block of chalk *H*, and is automatically rewound by the spring in the barrel *G* and the train of gearing *E D*.

Chalk-line Reel. A spindle or barrel on which a chalk-line is wound. See CHALK-LINE.

Chal'lis. (*Fabric.*) An elegant dress article of silk warp and worsted yarn; introduced in 1832. It is made on a principle similar to the Norwich crape; only thinner and softer, and having a pliable and clothy dress instead of a glossy surface.

Cham'ber. 1. The place where a charge of powder is lodged in a fire-arm, cannon, mine, or blast-hole. Howitzers and mortars have sub-caliber chambers.

2. (*Hydraulic Engineering.*) The space between the gates of a canal-lock.

3. (*Vehicles.*) An indentation on the inner surface of an axle-box, to hold grease.

4. An apartment where sublimed objects are deposited, as sulphur, lamp-black, arsenic, zinc-white, mercury, and other condensible fumes.

5. (*Dyeing.*) A form of apparatus for steaming printed cloths, to fix the colors. (See STEAM-COLORS.) It is about 12 × 9 feet, and 9 feet high, the interior furnished with frames which run in and out upon rollers when the front door is open. The frames have cross-rods provided with tenter-hooks for suspending the cloths.

6. (*Founding.*) *a.* The portions of a mold which contain the exterior form, and which are closed over the core in casting hollow-ware.

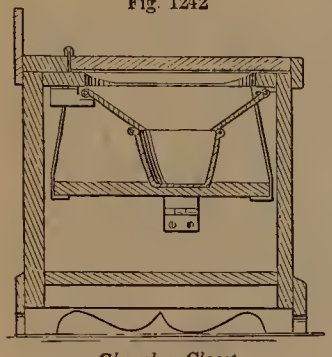
b. An inclosed space, as the *fire-chamber* of a furnace.

7. A short piece of ordnance for making a noise at celebrations.

8. The part of a pump in which the bucket or plunger works.

9. A urinal for the bedroom.

Fig. 1242



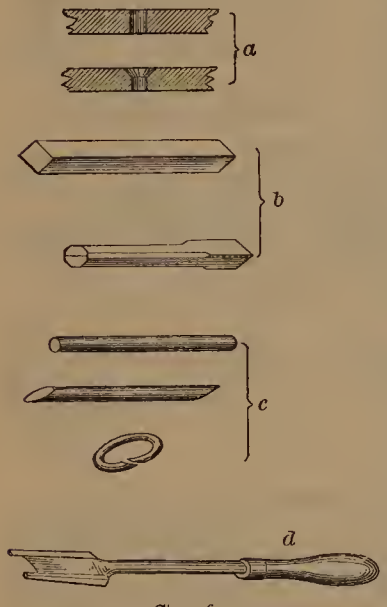
Chamber-Closet.

Cham'ber-clos'et. A commode or night-chair for invalids and the infirm. The seat has a funnel which enters the urinal, and india-rubber packing prevents the escape of effluvia. See EARTH-CLOSET.

Cham'ber-gage. (*Ordnance.*) One used in verifying the size of a howitzer or mortar-chamber.

Cham-bray'. (*Fabric.*) A kind of gingham; plain colors, linen finish, ladies' dress-goods.

Fig. 1243.



Chamfers.

Cham'fer. A bevel or slope conferred upon an edge which was originally rectangular.

a, chamfered hole to receive a screw-head.

b, a chamfered pin.

c, a chamfered rod, ready for welding into a link.

d, harness-maker's chamfering-tool.

Cham'fer-ing-bit. A boring-tool with a conical cutter adapted to chamfer the edge of a hole to enable it to receive the head of a screw. See BIT.

Cham'fer-ing-tool. (*Saddlery.*) A tool (*d*, Fig. 1243) for paring down the thickness of a leathern strap near the edge, making a chamfer.

It is called *thinning* the edge, and is sometimes preliminary to sewing, and at other times to fitting the edge into its place in the harness.

Cham'fret. 1. (*Carpentry.*) A groove or furrow.

2. A bend produced by cutting off the edge of a right angle. See CHAMFER.

Cham'fret-ing. (*Building.*) The splay of a window, etc.

Cham'ois. (*Shammy; chamois-leather.*) The name indicates that this leather is made from the skin of the chamois (*Rupicapra tragus*), but the skins of sheep, goats, deer, calves, and the split hides of other animals, are used for the making of this kind of leather; the superior kinds of which are called *chamois*, and the inferior, *wash-leather*.

The skins are unhaired in a lime-vat, and scraped on a beam in the ordinary way. The lime is removed in a bath by lactic or acetic acid, and the skins are then *frizzed*.

This process consists in rubbing the skins with pumice or the blunt end of a round knife, until the grain is removed, the skin softened, and reduced to an even thickness throughout.

The skins are then pressed to expel water, fulled by wooden hammers, spread, treated with oil, — fish-oil being preferable, — rolled up and again fulled, to distribute the oil throughout the bundle. They are then taken out, unfolded, dried, re-oiled, and again rolled and fulled. These processes are repeated till the effect is fully accomplished, heat being applied during the latter portion, by means of suspending the skins in a store-room.

Superfluous oil is removed by a short steeping in a dilute alkaline lye; the skins are then wrung, dried, suppled by stretching, and polished by rolling.

Cham-pign'on-rail. (*Railroad Engineering.*) One having a rounded upper surface.

Chan'cel. That part of the choir, or eastern part of a church, between the altar or communion-table and the rail that incloses it.

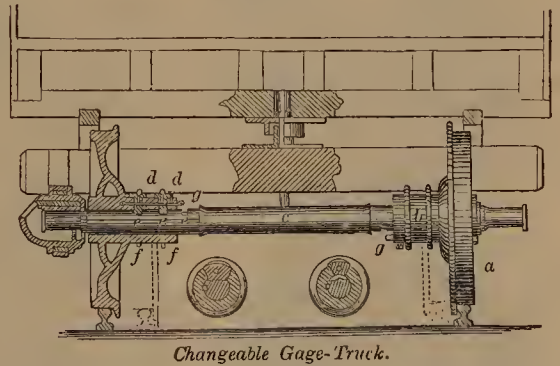
Chan-de-lier'. A frame with branches to hold candle-sockets. The word now includes a frame with gas branches, though the latter is technically a *gasalier*.

A chandelier in the palace of the Khalif of Cordova, A. D. 1100, contained 1,084 lamps. Cordova was then the intellectual center of Europe, and the royal dwellings of Germany, France, and England were like stables.

2. An obsolete term for a movable frame of fascines to cover a working party.

Change'a-ble Gage-truck. A means of adjusting wheels to different gages of tracks, by making the wheels adjustable on the axles. The arrange-

Fig. 1244.



Changeable Gage-Truck.

ment is shown in Fig. 1244; one wheel in section, the other in elevation. The two views below the truck are sections transversely of the axle. The wheels are cast with an elongated hub or sleeve *b* projecting inwards, in which there are two slots, and in the axle there are corresponding recesses which admit of the wheels being firmly fixed to the axle by means of V-shaped wedges or blocks *d d*. Two india-rubber bands or rings *f f*, fitting tightly, are placed over the openings in the sleeve, thus holding the wedges in position; and they are farther secured by a split-pin with curved ends, which is passed lengthwise through the sleeve and wedges, and expands at the inner end in an enlarged opening. As an additional security, also, there is a set-screw *g* passing through the sleeve, which is made to press upon the split-pin, thus preventing the possibility of the latter ever being jerked or shaken out whilst

running. The gage is changed by merely removing the wedges, and then passing the wagons over a converging or diverging track, as the case may be, and the usual time occupied in changing is from five to ten minutes for each car.

Change-pump. A pump introduced by the successors of Boulton and Watt in connection with the boilers of sea-going vessels, in order to keep a continual change in the body of water, removing the super-salted water and substituting sea water.

The change-pump has been superseded by the blow-off cock, which, being turned at intervals, allows a portion of the super-salted water to escape overboard. External condensation and fresh-water boiler-supply are now the mode.

Change-wheel. (*Machinery.*) *Change-wheels*, having varying numbers of cogs of the same pitch, are used to connect the main arbor of the lathe with the feed-screw, so as to vary the relative rates of rotation and consequently the pitch of the screw to be cut.

The first application of *change-wheels* to a lathe is supposed to have been in a fusee-cutting lathe, described in a work, 1741. The change-wheels are intermediate, and journaled in a bracket, which permits them to be brought into engagement with the rotative and feed wheels respectively. See SCREW-CUTTING LATHE; ENGINE-LATHE.

Chan'nel. 1. (*Shipbuilding.*) *Chain-wale.* A flat ledge of wood or iron projecting outward from the ship's side, for spreading the shrouds or standing rigging at each side of the masts, and protecting the chain-plates. The channels are at the level of the deck beams.

2. (*Nautical.*) The rope track in a tackle-block.

3. (*Boot-making.*) The cut in the sole of a boot to hold the thread and allow the stitches to sink below the surface of the sole.

4. A long groove cut in a stone on a line where it is to be split.

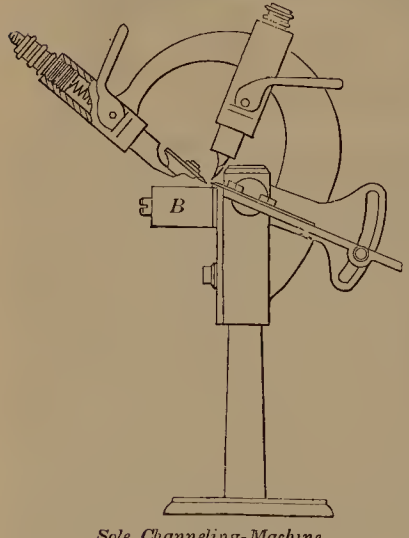
5. (*Mining.*) An air conduit or pipe, to conduct air into a mine.

6. (*Founding.*) A trough to conduct melted metal to the pig-bed or mold.

Chan'nel-ing. (*Architecture.*) Perpendicular channels, or cavities, cut along the shaft of a column or pilaster.

Chan'nel-ing-ma-chine'. 1. (*Boot-making.*) One for cutting the channels in boot-soles, to allow the thread to bury itself in the leather and be protected from immediate wear. It consists of a knife, which makes an oblique cut in the sole, to a gaged depth and regulated as to distance from the sole-edge by a guide.

Fig. 1245.

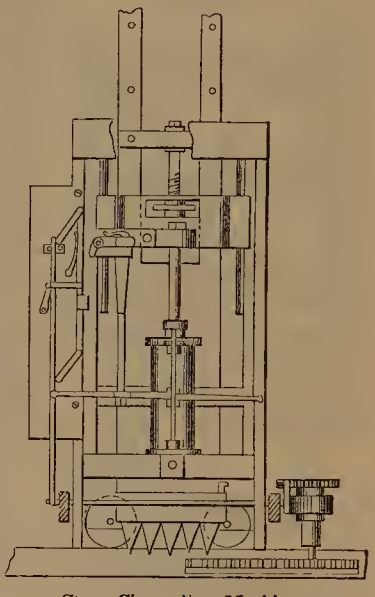


Sole Channeling-Machine.

In the example, the sole rests upon the roller *B* and its edge against the guide; it is then pressed forward against the knives. One of the latter is presented obliquely upon the surface of the sole, and cuts the channel; the other has an oblique (nearly opposite) presentation, and slices off the upper edge of the sole, leaving it beveled.

2. (*Stone-working.*) A machine having a series of jumpers or chisels which make a groove across the face of a block in the quarry, or detached. In the illustration shown, the machine has a gang of cutters operated by direct-acting steam-cylinder. The cutters have direct motion from the piston. The valve is reversed at the blow of the cutters; or, in case of no blow being given, it is reversed before the cylinder - bottom is touched by the piston. The cutter-bar is adjustable on the cylinder-bar, to suit the depth of groove cut. The whole mechanism is mounted on vertically adjustable rollers, and the feed-device is operated from the cross-head.

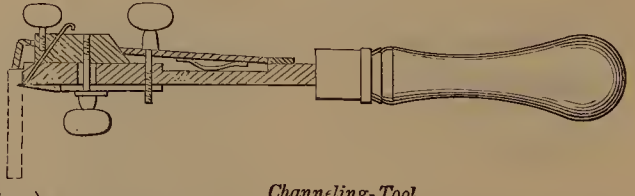
Fig. 1246.



Stone Channeling-Machine.

Chan'nel-ing-tool. A tool used for cutting a channel near the edge of a piece of leather, so as to hide the sewing. Used in making round work, such as running reins, whips; also in sinking grooves in shoe-soles, to hide the stitching. The cutter is adjustable on the shank, for penetration, and the guide at the end to gage the distance of the channel from the edge of the leather.

Fig. 1247.



Channeling-Tool.

Chan'nel-i'ron. 1. A form of angle-iron having a web with two flanges extending only on one side of the web.

2. (*Building.*) A brace or hook to support the guttering.

Chan'nel-wale. (*Shipbuilding.*) One of the strakes between the ports of the gun-deck and upper deck of large vessels.

Chant'er. (*Music.*) The tenor or treble pipe of a bagpipe.

Chant'late. (*Building.*) A projecting part of the roof-sheathing at the eave, to carry the drip clear of the wall.

Chap. A *cheek* of a vise. One of the *jaws*. *Chop.*

Chape. 1. The catch or piece by which an object is attached, — to a belt, for instance; as the piece of leather known specifically as the *frog*, to which a bayonet-scabbard is attached, and which slides on the belt; or a piece used to fasten a buckle to a strap or other piece of leather.

2. A plate on the back of a buckle, or the bar of a buckle, by which it is attached to a belt.

3. The hook of a scabbard.

4. The plate at the point of a scabbard. The *tip*.

Chap'el-et. 1. (*Hydraulic Engineering.*) *a.* A dredging or water-raising machine, consisting of a chain provided with scoops or scuttles, or with pallets traversing in a trough; the chain moving over rollers or wheels, of which the upper one is driven by power, and the lower one is vertically adjustable so as to regulate the position of the scoops or pallets, to bring them against the mud to be lifted, or to submerge them in the water to be raised. See CHAIN-PUMP; DREDGING-MACHINE.

b. A French name for the chain-pump in which the cushions or buttons which occur at intervals on the chain are compared to the beads of the rosary. Hence also known as *paternoster* pumps.

2. (*Saddlery.*) A pair of straps with stirrups, joined at the middle and secured to the frame of the saddle.

Chap'let. (*Architecture.*) A small molding decorated with round or oblong beads, or other similar forms.

Char'coal. Charcoal consists of wood burned with but little access of air. Billets of wood are built into a heap, which is covered with earth or sand. The heap is fired at openings left near the bottom of the pile, and the gases escape at small openings above.

For making fine charcoal, such as that of willow, used in the manufacture of gunpowder, the wood is burned in iron cylinders, or rather retorts, in which a process of destructive distillation removes the volatile hydrocarbons, pyroligneous acid, etc. By this more perfect means the process is accurately regulated.

Charcoal is used in the arts as —

A fuel.

A polishing powder.

A table on which pieces of metal are secured in position to be soldered by the blow-pipe.

A filtering material.

A defecator and decolorizer of solutions and water.

An absorbent of gases and aqueous vapors.

A non-conducting packing in ice-houses, safes, and refrigerators.

An ingredient in gunpowder and fire-works.

In the galvanic battery and the electric light.

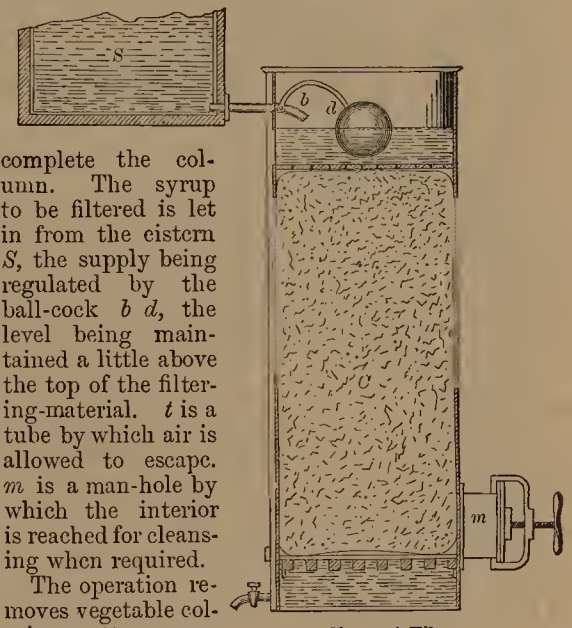
Char'coal, An'i-mal. (*Sugar-refining.*) Animal charcoal is prepared by calcining bones in closed vessels. These are either retorts, similar to those in which coal is distilled for the production of illuminating gas, or they are earthenware pots piled up in kilns and fired. Charges of fifty pounds of bones to a pot will require, say, sixteen hours of firing. The bones are then ground between fluted rollers, the dust removed, and the granulated material used for charging the filters of the sugar-refiner. The material is used for removing color, feculencies, and fermenting ingredients from the syrup. See BONE-BLACK FURNACE.

Char'coal-cool'er. A wire cylinder in which animal charcoal is agitated and cooled, after revivifying, while a current of air carries off the noxious gases.

Char'coal-fil'ter. A filter charged with ordinary or animal charcoal for domestic use, or with animal charcoal for use in the sugar-house or refinery.

The filter for the removal of feculent and other matters held in suspension in the clarified cane-juice is a high cylindrical vessel charged with bone-black. Upon the perforated bottom a filter-cloth is spread, and upon this a layer of bone-black is tightly packed; over this the main body of animal charcoal *C* is piled in loosely. Another cloth and a perforated plate

Fig. 1248.



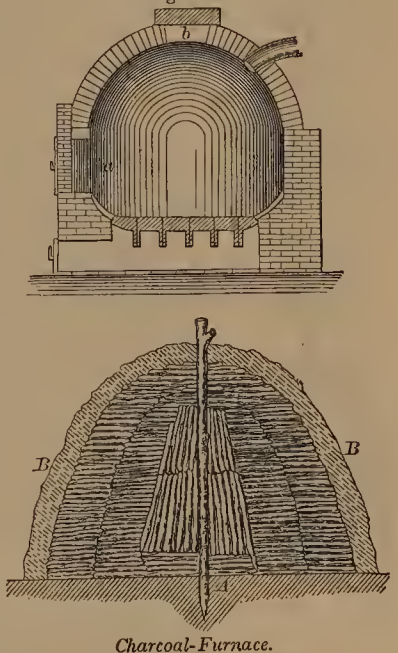
Charcoal-Filter.

complete the column. The syrup to be filtered is let in from the cistern *S*, the supply being regulated by the ball-cock *b d*, the level being maintained a little above the top of the filtering-material. *t* is a tube by which air is allowed to escape. *m* is a man-hole by which the interior is reached for cleansing when required.

The operation removes vegetable coloring-matter, excess of lime derived from the clarifying, mineral salts, and particles in a fermenting stage.

Char'coal-fur'nace. A furnace for producing charcoal by the dry distillation of wood, and for the collection of the tar and pyroligneous acid resulting therefrom.

Fig. 1249.



Charcoal-Furnace.

The air passes in between the bars of the grate, and is regulated as to quantity by a closely fitting ash-pit door. The wood is built in at the openings *a b*, and the charcoal extracted at *a*. When sufficient heat has been obtained, the access of air is prevented, and the carbonization proceeds, the volatile matters passing off at the neck above, to be collected and separated. The lower figure shows the mode of building a charcoal-heap. *A* is the central post, *B* an earthen covering.

Char'coal-point. A pencil of carbon prepared for use in the electric-light apparatus.

Charge. 1. The body of ore, metal, fuel, or other matter introduced into a furnace at one time, for one heat, or one run, as the case may be.

The *charge* of a puddling-furnace is about 500 pounds of pig-iron, and this forms 4 blooms.

The *charge* of a gas-retort is 220 pounds, introduced in two scoopfuls of 110 pounds each.

The *charge* of a tumbling-box is as many castings

or other matters as it will conveniently contain and give room for mutual attrition.

The *charge* of an amalgamating pan is according to size. They vary from 4½ to 6 feet in diameter; some work off two tons in twenty-four hours, others a *charge* of 1,400 pounds in three or four hours.

And so on.

2. The amount required to furnish an implement or machine for a single operation; as, —

The *charge* of a gun. The *service-charge* for smooth-bored guns may be ⅓ to ¼ the weight of the projectiles. For *hot-shot* and *ricochet* firing these charges are reduced. Rifled guns, avoiding windage, require a smaller charge than smooth-bores. The service-charge of the Armstrong gun is one eighth the weight of the projectile.

In the navy three charges are used: *distant*, *full*, and *reduced*.

The weight of a gun ranges in smooth-bores from 500 to 700 times, and in rifled guns from 600 to 800 times, the weight of the service-charge of powder.

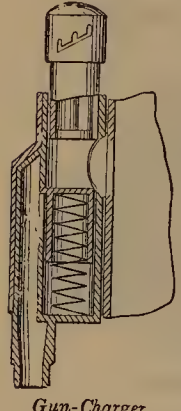
The weight of the carriage (shipboard) is about one fifth that of the gun. The weight of the spherical shot is about four times that of its service-charge; and of cylindrical shot, eight times. The weight of the cast-iron sphere, in pounds, is equal to the cube of the diameter, in inches, multiplied by 0.134 nearly. Weight of a steel sphere, in pounds, is equal to cube of diameter, in inches, multiplied by 0.148 nearly.

The explosive energy of gunpowder completely burned is estimated at from 240,000 to 300,000 foot pounds, per pound of powder. Owing to incomplete combustion, and other causes of loss, its energy communicated to cannon-shot is considered to be from 144,000 to 192,000 foot pounds, per pound.

The velocity is thus calculated: —

"Divide the energy due to the powder by the weight of the shot; the quotient is a hight in feet which is to be multiplied by 64.4; the square root of the product will be the initial velocity of the shot in feet per second." — RANKINE.

Fig. 1250



Gun-Charger.

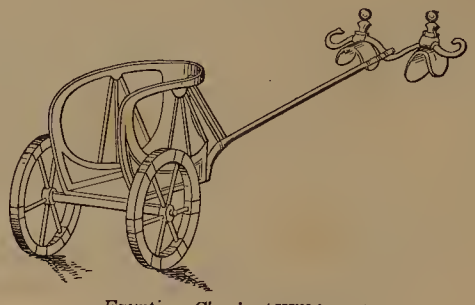
Char'ger. 1. (*Mining.*) A spiral instrument for charging horizontal blast-holes.

2. A device for dropping into the bore of a fowling-piece from a shot-belt or pouch a gaged quantity of shot. By forcing down the plunger the communication with the pouch is closed, and the charge is allowed to pass to the tube, which conducts it to the gun. The piston-head is adjustable, to vary the capacity of the charge-chamber.

Char'i-ot. 1. An ancient two-wheeled vehicle, drawn by horses attached to a pole, and used in state processions, in warfare, and for racing.

The Egyptian chariot was light, made principally of wood, and rested on an axle upon which the wheels were secured by linch-pins. In many cases, however, it would appear that the wheels were fixed to the axle, which turned with them. The floor of the car was sometimes made of latticed thongs, to give it a certain amount of elasticity to the rider, who always stood, unless he sat on the edge, as the car had no seat. The body was strengthened with leather and metallic bands. The pole was inserted into the middle of the axle, and rested in front upon saddles which bore upon the withers of the horses and were secured in place by collars and belly-bands. The chariots had invariably two wheels, which were strengthened at the junctions of the fellies by bronze bands and bound with metallic tires. In some cases

Fig. 1251.

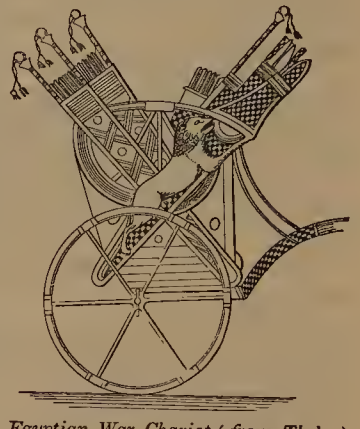


Egyptian Chariot (Wilkinson).

the fellies appear to have been made by beuding a single strip around a former. The pole, according to Homer, was about 13½ feet long, and the yoke was attached to it by a strap and a pin, and sometimes was connected by a single trace to a part nearer to the chariot. No double traces are noticed.

The accompanying cut shows the war-chariot with all its rigging, bow-cases, quivers, and maces. The arrangements are graceful, and the ornamentation is florid. Chariots represented on the ruins at Persepolis are the same in essential points of construction. The horses are hitched by a yoke to the carriage-pole, the saddles resting on the withers, as before stated in regard to the Egyptian mode.

Fig. 1252.

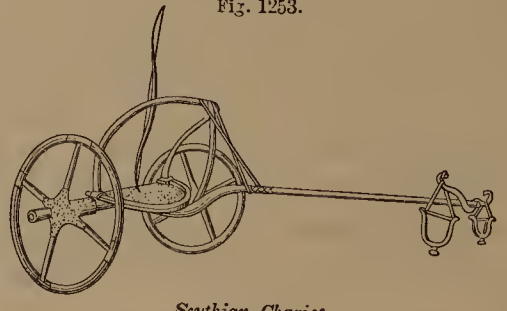


Egyptian War-Chariot (from Thebes).

A four-wheeled hearse occurs on several of the tomb-paintings in Egypt. See HEARSE.

Fig. 1253, from Wilkinson, represents an ancient Scythian car actually found in Egypt and preserved in the Florentine Museum. It is believed to have

Fig. 1253.



Scythian Chariot.

been taken as a spoil from Scythia by the Egyptian conqueror.

War-chariots do not appear in any Egyptian monuments prior to the eighteenth dynasty.

The price of an Egyptian chariot in the time of Solomon was 600 shekels of silver, about $300; an immense price, considering the then value of money.

The first horses and chariots are represented at Eileithyias at the time of Ames or Amosis, about

1510 B. C. They do not appear to have been used in Egypt during the time of the Osirtasens.

Herodotus says that "the Greeks learnt from the Libyans to yoke four horses to a chariot" (IV. 189). It is, however, mentioned by Homer (*Iliad*, viii. 185; *Odyssey*, xiii. 81).

In the Assyrian chariots a spare horse was sometimes attached by a single inside trace to the chariot. The Lydians, it is said, had sometimes several poles to their chariots and horses between each. This resembles the modern shafts. The origin of shafts, however, must be looked for in another direction. In the primitive form, shafts consisted of a pair of poles attached by girth and breast-band to the sides of a horse and dragging behind. The load was laid upon the rear end. Thus the North American Indians move their lodges.

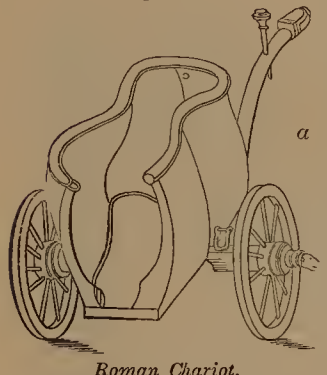
In the triumphal procession of Ptolemy Philadelphus were: —

24 chariots drawn by 4 elephants each.
60 chariots drawn by 2 goats each.
12 chariots drawn by antelopes.
7 chariots drawn by oryxes.
15 chariots drawn by buffaloes.
8 chariots drawn by 2 ostriches each.
7 chariots drawn by gnus.
4 chariots drawn by 2 zebras each.
4 chariots drawn by 4 zebras each.

On all these animals rode boys wearing wide-awake hats (*petasi*).

The chariot of the Greeks and Romans had two wheels, and but one pole usually, although some of the Lydian chariots had two or even three poles.

Fig. 1254



Roman Chariot.

The body had an elevated forward portion, answering to our *dash-board*, and called the *antyx*. The annexed cut *a* is from an ancient chariot preserved in the Vatican. The body was sometimes of light open-work, or even of wicker.

The pole was the sole means of draft, and was mortised into the axle. Two horses were always used. If more were added, each was attached by a trace on the side towards the pole-horses. The yoke was attached by a pin to the pole, and rested just in front of the withers of the horses. They pulled by the yoke, which was secured by breast-bands and sureingles to the animals. See HARNESS.

This mode of drawing was universal. The lateral horse had a collar, from whence the trace passed to the rim of the car.

One exception, perhaps, must be made. It is possible that the Roman *cisium*, a kind of gig, had shafts, and was drawn by one horse.

The axle was usually of oak, but sometimes of ilex, ash, or elm. The body was secured thereto, and to the pole, which was mortised into the axle and braced or strengthened by irons. The spindles or arms of the axle were of wood; no *skeins*, so far as we are informed.

The wheels revolved on, not with, the axles, and were secured by linch-pins. They consisted of nave, spokes, fellies, and tire, all usually of wood. We read of bronze tires, but they were exceptional. The fellies were bent.

The ancient Britons were celebrated for their skill and prowess in chariot-warfare. Their chariots were open in front instead of behind; the poles were wide, and the charioteer ran out upon the pole and discharged his javelin (*cateia*), even standing upon the yoke, and then retreating to the car.

The skill of the ancient Britons in chariot-driving filled Julius Cæsar with astonishment. See CARRIAGE; CART.

Chariot-wheels of bronze are preserved in the Berlin Museum, and one of wood of ancient Egypt is in the Abbott Collection, New York Historical Society.

2. The modern chariot is a stately four-wheeled pleasure-carriage having one seat.

Char'i-o-tee'. A four-wheeled pleasure-carriage having two seats covered by a calash-top.

Char-kan'a. (*Fabric.*) A checked Dacca muslin.

Char-ov'en. A furnace for carbonizing turf.

Char'ring-chis'el. A broad nigging-chisel, used in *charring* or hewing stone.

Chart. 1. A representation of a portion of the earth's surface projected on a plane. The term is commonly restricted to those intended for navigators' use, on which merely the outlines of coasts, islands, etc., are represented.

2. A sheet exhibiting a statement of facts in tabular form, so arranged that any particular may be readily referred to.

Hipparchus, of Alexandria (160 – 125 B. C.), reduced geography to a science, determining the latitude and longitude of places by celestial observations.

The geography of Ptolemy was translated into Arabic by the command of the Khalif Al Maimoun, between 813 and 833 A. D.

Charts were introduced into the marine service by Henry, son of John I. of Portugal, about A. D. 1400; brought to England by Bartholomew Colon in 1489.

Mercator's chart is a projection of the surface of the earth in the plane, with the meridians parallel to each other, the degrees of longitude all equal, and the degrees of latitude increasing in a corresponding ratio towards the poles. It was introduced by Gerald Mercator in 1556.

The principle of its construction had, however, been previously explained by Edward Wright.

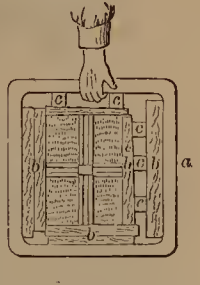
The first computation of longitude from the meridian of Greenwich Observatory was in 1679.

The first magnetic chart was constructed by Dr. Halley, in 1701. It was limited to the Atlantic and Indian Oceans.

Char-tom'e-ter. An instrument for measuring maps and charts.

Chase. 1. (*Printing.*) A rectangular iron frame (*a*, Fig. 1255) which receives the matter from a *galley*, and in which it is arranged in columns or pages, and *locked up* in order for printing. *Rules* (if necessary) and *furniture* for spacing the pages are placed between the pages, and all locked firmly in the *chase* by wedges *c c c*, called *quoins*.

Fig. 1255.



Chase.

The *furniture*, *b b b*, consists of slips of wood or metal, half an inch in thickness, and of any required length.

Those at the head, foot, and side are called *head-sticks*, *foot-sticks*, *side-sticks*. Those between the pages are called *gutters*.

Gutenberg used screws to lock up his form in the chase. Quoins came later.

2. (*Ordnance.*) *a.* The portion of a gun forward of the *trunnions* to the *swell* of the muzzle. In modern guns, the *swell* is suppressed, and the *chase* extends to the *muzzle*.

b. A *chase*-gun is one mounted at the bow to fire at a vessel being chased. It is fired from a *chase*-port.

3. (*Masonry.*) A groove cut in the face of a wall.

4. (*Shipbuilding.*) A kind of joint by which an *overlap*-joint gradually becomes a *flush*-joint, as at the hooding-end of *clinker-built* boats. A gradually deepening rabbet is taken out of each edge at the lands, so that the projection of each strake beyond the next below it gradually diminishes, and they fit flush with each other into the rabbets of the stem and stern post.

5. A groove, trench, or passage of a given width and depth to fit an object which traverses or fits therein; as, —

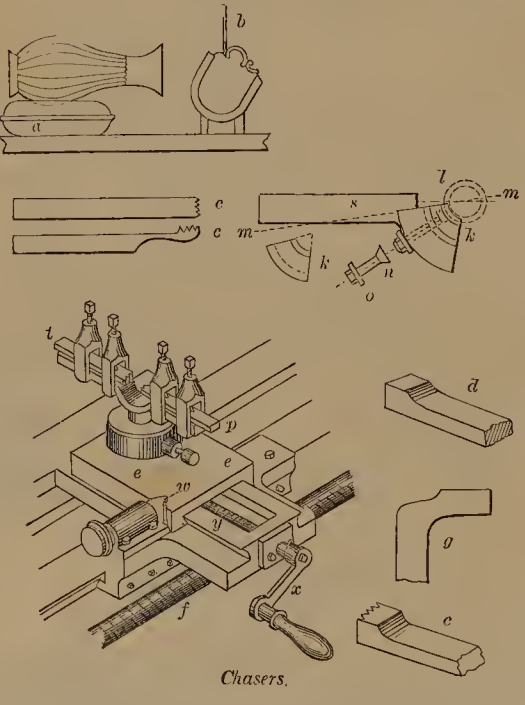
The *chase* or curved water-way, or *breast* in which a *breast-wheel* or *scoop-wheel* rotates. The sides of the *chase* fit as nearly as possible to the wheel, to prevent waste of water.

The trench made by spades or machines for the reception of drain-tile.

Chas'er. 1. (*Machinery.*) A tool for cutting threads in the hand-lathe; sometimes called a comb, from its having a row of projecting teeth (*c c c*, Fig. 1256).

It is made of steel, and the teeth filed by hand or by a cutting *hub*. It is first forged in blank in the form of *d* for an outside chaser, or in the form of *g*

Fig 1256.



Chasers.

for an inside chaser. The teeth are then filed or made by a *hub* (which see). The latter is a steel mandrel rotated on the centers of a lathe and having a section of screw-thread cut upon it. The thread is notched in places, so as to make cutting edges.

By holding the edge of the *chaser*-blank against the *hub* the teeth are cut in the former, and it is ready for tempering. It may then be used in cutting or finishing screw-threads on a bolt or rod, or in a socket or coupling, as the case may be, or may be used in making a *hub* on a mandrel of softened steel turned down to the right size and shape.

The chaser is dispensed with in power-lathes, which are provided with trains of gears for varying pitch and with automatic feed, the work being rotated slowly, the chaser supported in a rest, and sliding therewith at a rate determined by the pitch of the feed-screw and the rate of rotation of the work.

In the chasing-engine (Fig. 1256), the cutter *k* is made as a ring of steel, which is screwed internally to the diameter of the bolt *l* which is to be threaded, and turned externally with an under-cut groove, for the small screw *n* and nut *o*, by which it is held in an iron stock *s* formed of a corresponding sweep; for distinctness, the cutter *k* and screw *n* are also shown detached. The center of curvature of the tool is placed a little below the center of the lathe, to give the angle of separation or penetration. After the tool has been ground away, in the act of being sharpened, it is raised up until its points touch a straight edge applied on the line *m m* of the stock. This denotes the proper hight of center, and also the angle to which the tool is intended to be hooked, namely, 10°. Each ring makes four or five cutters, and one stock may be used for several diameters of thread.

In Shanks's arrangement for *cutting screws* in a lathe, a front and a back chaser are employed, so that one may cut while the slide traverses in one direction, and the other during the return-movement. *p* represents the front and *t* the back tool, which are mounted on one slide *c c*, and all three are moved as one piece by the handle *x*. In the first adjustment, the wedge *w* is thrust to the bottom of the corresponding angular notch in the slide *c*, and the two tools are placed in contact with the cylinder to be threaded. For the first cut, the wedge *w* is slightly withdrawn, to allow the tool *p* to be advanced toward the work; and for the return-stroke, the wedge is again shifted under the observation of its divisions, and the slide *c* is brought forward towards the workman, up to the wedge; this relieves the tool *p* and projects *t*, which is then in adjustment for the second cut; and so on alternately. The command of the two tools is accurately given by the wedge, which is moved a small quantity by its screw and micrometer, between every alternation of the pair of tools, by the screw *y* operated by the handle *x*.

Punches or gravers are used for embossing or engraving the surfaces of metal, the design being in low relief or cut in intaglio. See also ENCHASING.

In the embossing by punches, the object is filled with lead or pitch, and laid on a sand-bag *a*, or in a *pitch-block*, while the chasing-tool *b* is held vertically and driven by a hammer. Some portions of the metal are thus driven inward, while those around rise up from the displacement and reaction of the pitch.

The chasing-tools are of various kinds, with flat, rounded faces and curved edges, so as to follow a pattern. Other tools have faces ornamented with designs in cameo or intaglio, which are conferred upon the metal by the action of the punch and hammer.

Chasing by the graver may be merely engraving in lines, but is usually in the form of relief; parts of the metal being cut away, leaving protuberant portions of ornate form, and which are farther beautified by graver-lines, frosting, milling, etc. The sand-bag supports the work while being chased by the graver.

The art of chasing was much practiced among the Greeks. Two celebrated examples of chasing in iron are: —

The iron base of the vase made by Glaucus of Chios, and dedicated to the Delphic oracle by Alyattes, king of Lydia. This had small figures of animals, insects, and plants.

The iron helmet of Alexander, the work of Theophilus.

The principal chasing of antiquity was upon weapons, armor, shields, chariots, tripods, quoits, candelabra, chairs, thrones, mirrors, goblets, dishes.

The art arrived at great perfection in Etruria.

> "But none the golden bowl can chase,
> Or give to brass such varied grace,
> As that renownèd, hardy race
> That dwells by Arno's tide."
> CRITIAS, quoted by Athenæus (A. D. 220).

2. (*Metallurgy.*) One of the edge-wheels which revolves in a trough, to grind substances to powder. (See CHILIAN MILL; MORTAR-MILL; OIL-MILL.) Also used in grinding ore for puddling-furnaces, etc.

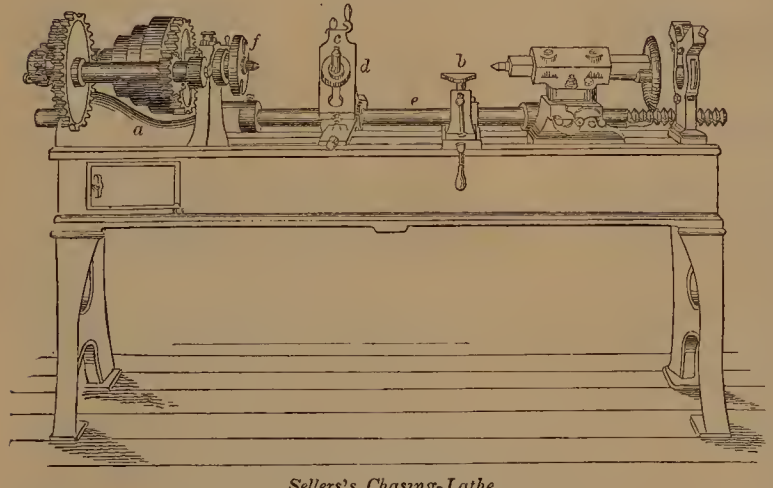
Chas'ing-chis'el. A punch used in enchasing. The mallet by which it is driven is the *chasing-hammer*, and the operation is performed on a *stake*. See CHASER.

Chas'ing-ham'mer. The mallet of the chaser in the operation of enchasing by embossing by punches. (See *a b*, Fig. 1256.)

Chas'ing-lathe. A screw-cutting lathe. So called from the name of the tool wherewith screws were cut by hand in the old form of lathe, before the slide-rest and feed-screw were invented.

In the illustration, which shows Sellers's improved

Fig. 1257



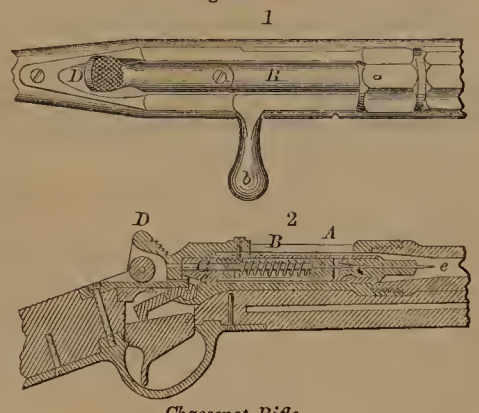
Sellers's Chasing-Lathe.

form of lathe for brass work, *a* is the live-head, which is back-geared. The spindle *c*, for holding the chasing-hobs, is so arranged as to accommodate two different pitches at the same time, or to cut with a single pointed tool either single, double, triple, or quadruple threads. The slide-rest *d* for the chaser is carried by a bar *e* at the back of the lathe; the counter-weight to chasing-bar presses either to or from the face-plate *f*; a poppet-head with square spindle and detachable screw for quick motion can be adjusted to any taper when used to carry turning-tools, and is provided with slide-rest movement. *b* is the hand-tool rest.

Chas'ing-tools. Those used by the chaser in the operation of embossing by punches. The work is laid on a chasing stake or cushion, and the punch struck by hammer or mallet. (See *a b*, Fig. 1256.)

Chasse'pot-gun. The breech-loading, center-fire needle-gun of the French service. It was designed as an improvement on the Prussian needle-gun, or *zündnadelgewehr*, to which it was opposed in the

Fig. 1258.



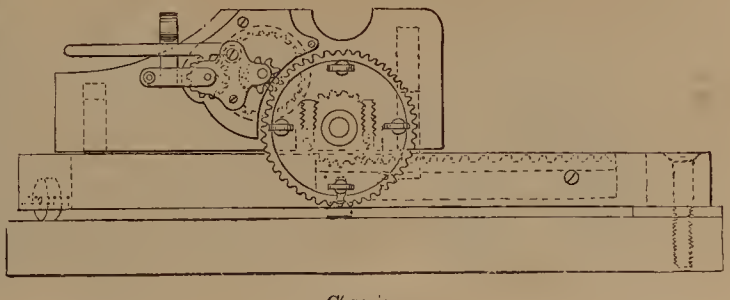
Chassepot Rifle.

Franco-Prussian war of 1871, and derives its name from the inventor. A paper cartridge is employed in the gun as originally constructed in 1867, but in 1869 M. Chassepot patented an improved arrangement, embracing a cartridge-retractor for use with a central-fire metallic cartridge; the construction of the gun is, however, essentially the same.

An opening on the right of the chamber *A* permits the insertion of the cartridge, which is effected by resting the butt of the gun, held in the left hand, against the left hip, turning the lever *e* from right to left and drawing it back, thus retracting the hollow cylinder or breech-block *B*; the cartridge is placed in the opening thus made, and is pushed home to its seat by a forward movement of the lever, which is then turned back to its original position, locking the breech-block in place. The shaft *C*, contained within the cylinder *B*, carries the needle *e*, and is drawn back by means of the knob *D*, compressing the spring which surrounds the shaft, until a detent thereon engages with the tumbler of the lock, holding the latter in cocked position. Pressure on the trigger allows the spring to act, driving the needle forward, penetrating the cartridge, and exploding the fulminate. A rubber washer at the inner end of the cylinder *B*, through which the needle passes, acts as a gas-check.

Chas'sis. (*Ordnance.*) The base-frame on which

Fig. 1259.



Chassis.

a barbette or casemate gun is run in and out of battery. The chassis is capable of a certain amount of lateral sweep, called *traverse*, so as to adjust the gun horizontally in pointing. This is frequently by oscillating in an arc, a pintle in front of the chassis being the center of oscillation. (See GUN-CARRIAGE.) In the example, the gun-carriage is moved on the chassis by a system of gears operated by a crank ; a lateral friction-compressor within the principal spur-wheel being employed to partially resist the recoil of the carriage. A windlass, operating on a toothed bar or rack attached to the chassis, controls the traversing or directing movement.

Chat'e-laine. A lady's waist ornament, with suspended charms, keys, etc.

Chat-roll'er. (*Mining.*) An ore-crushing machine, consisting of a pair of cast-iron rollers, for grinding roasted ore.

Chats. (*Mining.*) The central portion or stratum of a mass of ore in the process of washing.

Chat'ty. A porous earthen water-pot, used in India in refrigerating.

Chauf'fer. A small table-furnace. It may be of iron or of a black-lead crucible, fitted with air-holes and a grate.

Che-bec'. (*Nautical.*) A kind of vessel employed in the Newfoundland fisheries. Named from Chebacco (now Essex), a town in Massachusetts. Also called a *pink-stern.*

Check. 1. (*Fabric.*) A pattern produced by crossing stripes in the warp and the weft. The stripes may be of varying colors, or varying thickness, or both.

2. An East-Indian screen or sun-shade made of narrow strips of bamboo, four to six feet long, with connecting cords, and hung before doors or windows of apartments.

3. A card, plate, or tag in duplicate, used to identify articles placed promiscuously with others. See BAGGAGE-CHECK.

4. (*Music.*) A padded post on the back end of a piano-forte key, used to catch the head of the hammer in its descent and prevent rebounding, which might cause it again to strike the string. It is a feature of the *grand action.*

Check-bar. (*Music.*) A bar which limits the backward play of the jacks. See PIANO-MOVEMENT.

Check-bridge. (*Steam Engine.*) The fire-bridge of a steam-boiler furnace ; so called as it was supposed to check the too great freedom of draft which was carrying off the heat.

Check'er-ing-file. A compound file, consisting of two files riveted together, and whose edges project unequally, so that one acts as a *spacer* in checkworking the *small* of gun-stocks, etc. See DOUBLE FILE.

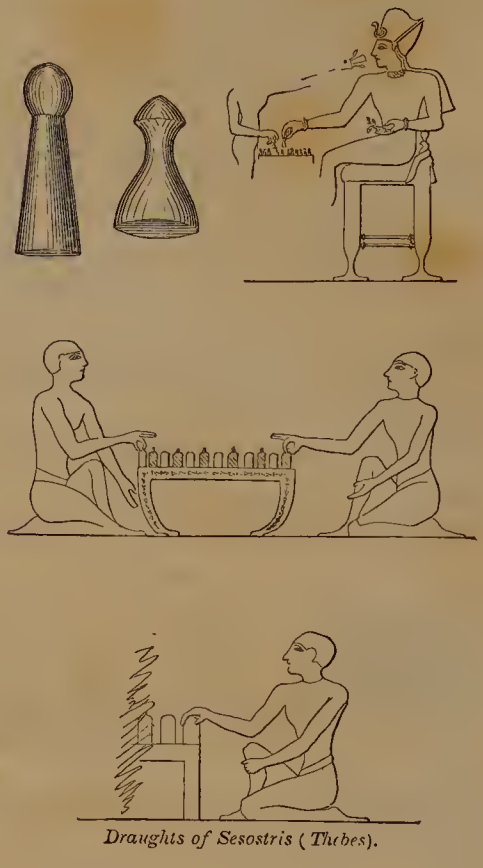
Check'ers. A game played with pieces of two colors on a board of sixty-four squares, whose alternating colors have given it the name of a checker-board. Also called draughts.

Rameses III., the great Sesostris of Herodotus, is represented, in his palace at Medinet Aboo and in a number of instances, playing at draughts ; generally with one of the ladies of his harem. The still older tombs of Beni Hassan (say about 2000 B. C.) have similar representations. The nature of the moves cannot be well determined ; the pieces of the respective players are diversely colored. They took each other, for in one figure of Rameses he has a handful of captives from the board. His lady is evidently losing, and is playfully holding a flower to his nose to divert his attention. They are both moving their pieces at once, however.

The pieces were of ivory, bone, or wood, and of the same general form ; but some had human heads differing for the respective sides of the board. The largest pieces are about $1\frac{1}{6}$ inches high and $1\frac{1}{8}$ in diameter.

The checkers of the Greeks and Romans was a game played with pieces, the sets being of different colors and sometimes assuming fanciful shapes. They

Fig. 1260.



Draughts of Sesostris (Thebes).

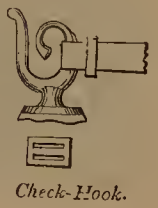
were sometimes pebbles (*calculi*), used as counters on the abacus, and were called by the epithets "thieves," "marauders" (*latrunculi*), "soldiers" (*civites*), "foes" (*hostes*), etc., indicating that the game represented a miniature combat.

There are indications among the Roman writers, that, in one form of the game, some of the men moved in a certain direction (*ordinarii*), while others had more liberty of movement and were termed *vagi.* This resembles chess. A man inclosed between two others was in *check* (*alligatus*) and was taken from the board.

The *abacus*, in which it was played, was marked with lines or divided into squares. There were, no doubt, several modifications of the game. (See ABACUS.) Sometimes the moves were determined by dice (*tesserœ*), like our backgammon and trie-trac. See DICE.

Check-hook. 1. A device in hoisting and lowering apparatus, designed to stop the motion of the wheel over which the rope runs, if the machinery becomes unmanageable. On the pulley are hooks which fly out by the centrifugal force when the speed becomes excessive, and engage stoppins which arrest the rotation of the pulley and the descent of the cage.

Fig. 1261.



Check-Hook.

2. (*Saddlery.*) A hook on a gig-saddle for the attachment of a bearing-rein.

Check-line. (*Saddlery.*) The line which branches off from the principal rein. See CHECK-REIN.

Check-lock. A lock so applied to the door as to check or hold the bolts. The bolts of the check-lock do not themselves hold the door, but are the means of detaining the bolts which do.

Check-nut. A secondary nut, screwing down upon the former to secure it. A *jam-nut*, *lock-nut*, or *pinching-nut*.

Check-rein. (*Saddlery.*) The branch rein which connects the driving-rein of one horse to the bit of the other. In double lines, the left rein passes to the near side bit-ring of the near horse, and a *check*-line proceeds from the said left rein to the near bit-ring of the *off* horse. The right driving-rein passes directly to the off bit-ring of the off horse, and has a *check*-rein which connects with the off bit-ring of the near horse.

The horses of the Egyptian chariots had check-reins.

Check-rein Hook. See CHECK-HOOK.

Check-string. A cord by which the occupant of a carriage signals the driver.

Check-valve. A valve placed between the feed-pipe and the boiler, to prevent the return of the feed-water. See ALARM CHECK-VALVE; BACK-PRESSURE VALVE.

Cheek. One of the corresponding side-plates or parts of a frame or machine; more frequently used in the plural, as —

1. The side-pieces of a gun-carriage on which the trunnions immediately rest; also called brackets.
2. The shears or bed-bars of a lathe on which the puppets rest.
3. The projections on the side of a mast on which the *trestle-trees* rest.
4. The side-pieces of a window-frame.
5. The solid part of a timber on the side of the mortise.
6. (*Founding.*) The middle part of a *three-part* flask.
7. The *branches* of a bridle-bit.
8. The standards or supports, arranged in pairs, of such machines as the Stanhope or copper-plate printing-press, the rolling-mill, and many varieties of presses.
9. The sides of an embrasure.
10. The jaws of a vise.
11. The sides of a pillow-block which hold the boxing.
12. The miter-sill of a lock-gate.

Cheek-block. (*Nautical.*) A block, one side of which is formed by a cheek-piece secured to an object which forms the other side, as in the cheek-blocks near the ends of the yards for the sheets of the square sails. See BOOM-IRON.

Cheek-straps. (*Saddlery.*) Straps passing down each side of the horse's head and connected to the bit-rings.

Cheese. Milk-curd pressed into a shape and ripened.

Hippocrates (460 B. C.) states that the mode of preparing this food from milk was discovered by the Scythians at a very early date. There can be little doubt that it was a common article of food among the pastoral nations of Uz, Canaan and Asia Minor, as well as among the Scythians. The Egyptians, also, had immense herds of kine, goats, and sheep, and the curds of milk, soured naturally or artificially, must have been used. Curds are pressed to remove the buttermilk, and then become cheese. The ripening of cheese develops its flavor. Virgil describes cheese as the common food of the Roman shepherds.

Strabo records a difficulty experienced in former times by the Iberians in the vicinity of Gades (Cadiz): "The excellence of the pasturage is such that the milk of the cattle there fed does not yield any whey, and they are obliged to mix it with large quantities of water on account of its richness. After fifty days' pasturing, it is necessary to bleed the cows to keep them from choking. The pasturage is dry, but it fattens wonderfully." So it would appear.

Cheese is mentioned three times in the Old Testament Scriptures, but each time under a different Hebrew name. It was some coagulated and hardened production of milk. Burckhardt describes it as coagulated and dried buttermilk, ground, and eaten by the Arabs with butter.

Among a pastoral people great are the uses of milk. Cheese forms a staple article of diet to millions who know but little of agriculture. Jesse sent ten cheeses by the hands of David to the captain of the thousand in which the brethren of the latter served (1 Samuel xvii. 18); and "cheese of kine" were brought to David at Mahanaim (2 Samuel xvii. 29), 1023 B. C. Job complains, in his anguish, of his distemper: "Hast thou not poured me out like milk and curdled me like cheese?"

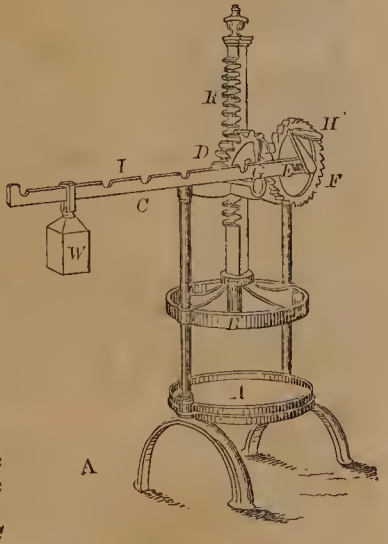
Cheese-cut'ter. A device for breaking the curd into small pieces, that the whey may more readily exude.

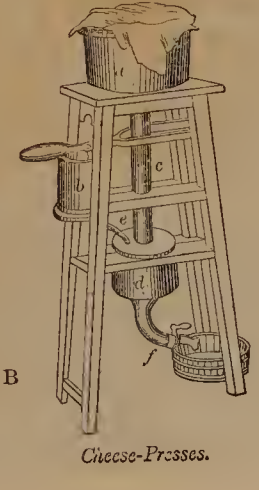
Cheese-hoop. An open-ended cylinder, usually of wood, in which curds are pressed, to expel the whey and acquire a form.

Cheese-knife. A large spatula, used in dairies to break down the curd.

Cheese-press. The cheese-press (*A*, Fig. 1262) is constructed of iron. The hoop containing the curd is placed on the bottom-plate *A*, and the upper plate *B* is made to descend upon it. There are two ways of doing this; one quick and easy, until the resistance becomes great, and the other slower and more powerful, and used for the conclusion of the operation.

Fig. 1262.





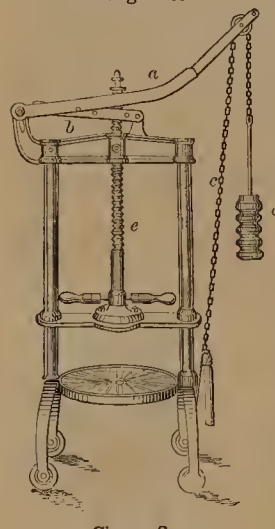
Cheese-Presses.

On the axis *C* of the wheel *D* there is a pinion of eight teeth, which works in the rack *R*. On the axis *E* there is another pinion of eight teeth, which acts in the wheel *D* of twenty-four teeth. This axis *E* may be turned by the crank-handle *H*, three turns of which will make the rack descend through a space equal to eight of

its teeth. In this way, the plate *B* may be lowered to touch the cheese, and to commence the pressure; but when the pressure becomes considerable, the second method of acting upon the rack is resorted to. On the axis *E*, besides the pinion before mentioned, there is a fixed ratchet-wheel *F*; the lever *I*, which embraces *F*, is also placed on this axis, but turns freely round it. A pawl or click, turning on a pin, may be made to engage in the notches of the ratchet-wheel *F*. By means of this arrangement, when *I* is raised up, and the click engaged in *F*, the axis *E* and its pinion will be turned round with great power on depressing the end *I* of the lever; and by alternately raising and depressing *I*, any degree of pressure required may be given to the cheese. The weight *W* may be suspended to continue the pressure.

The *Pneumatic Cheese-press B*, shown in the lower part of the same figure, consists of a stand about three feet high, on the top of which is a metallic vessel *a*, forming a *hoop* for the curd. This vessel has a loose, corrugated bottom covered with wire-cloth. The bottom of the vessel communicates by a pipe *c* with a receiver *d*, which is exhausted of air by means of an air-pump *b* and pipe *c*.

Fig. 1263.



Cheese-Press.

The curd being salted and placed in a cloth in the vessel *a*, the pump is worked and the pressure of the atmosphere drives the whey down through the curd, and it collects in the receiver, from whence it is discharged, as occasion may require, by means of the pipe and faucet *f*. The curd is then subjected to pressure in the usual manner.

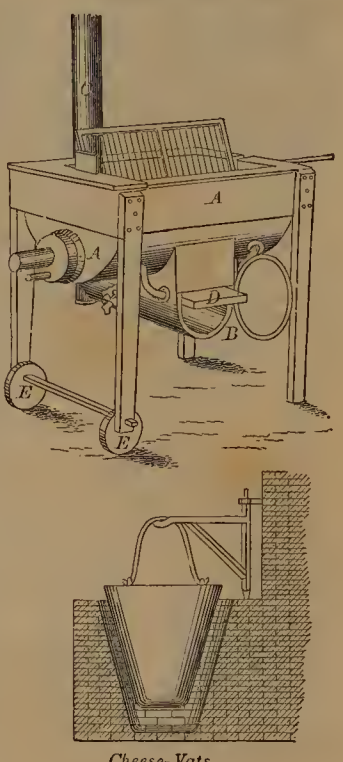
Another form of press involves the use of the toggle, as the leverage increases as the platen descends. The weight is suspended by a chain which runs over the pulley on the end of the long arm of the toggle. A hand lever operates the screw for quick movements.

Cheese-shelf. One constructed for holding cheeses during the process of ripening. Ingenuity has been exercised in saving the time in turning the cheeses singly day by day, by inverting the whole shelf with its row of cheeses.

Cheese-turn'er. A shelf capable of being inverted, so as to turn over the cheeses laid upon it, — a daily duty during the progress of the ripening of the cheese.

Cheese-vat. The necessity for preserving a certain temperature in cheese-vats has given rise to numerous devices, among which may be cited that illustrated at *A* in the accompanying cut. The vat *A* is semi-cylindrical and double-walled, water being contained between the shells. Under the vat is a furnace *B*, for heating the water, the smoke from which escapes by the pipes *C*. The degree of heat admitted to the water is regulated by a sliding damper *D*. A coil of circulating pipes is affixed to the outer shell of the vat, connecting with the water space at center and ends of the vat, thus equalizing the heat in the water space. Spouts are attached for drawing off the whey, the water from the water space, and discharging the curd. To aid in this, one end of the machine is set on eccentrics *E*. The wire frame cuts the curds into small blocks, and sweeps it from the inner surface of the vat.

Fig. 1264.

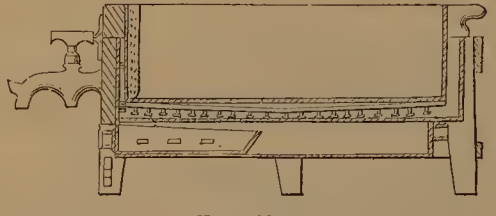


Cheese-Vats.

The vat used on the plains of the Po, where the Parmesan cheese is made, is shown in the lower figure. It is a copper caldron, slung from a crane over a conical fireplace, in which wood is burned. In this vat the milk is heated and coagulated, and without removing is broken by a stick having cross wires. The curd is then again heated, taken out, drained, salted, pressed, and in forty days is moved to the cheese-loft.

In Fig. 1265 the pan is hinged to the vat and rests upon pins within it; the contents are warmed by a furnace beneath; the whey drawn off by a strainer; adjustable legs permit the inclination of the vat.

Fig. 1265.



Cheese-Vat.

Chek'mak. (*Fabric.*) A Turkish fabric of silk and gold thread mixed with cotton.

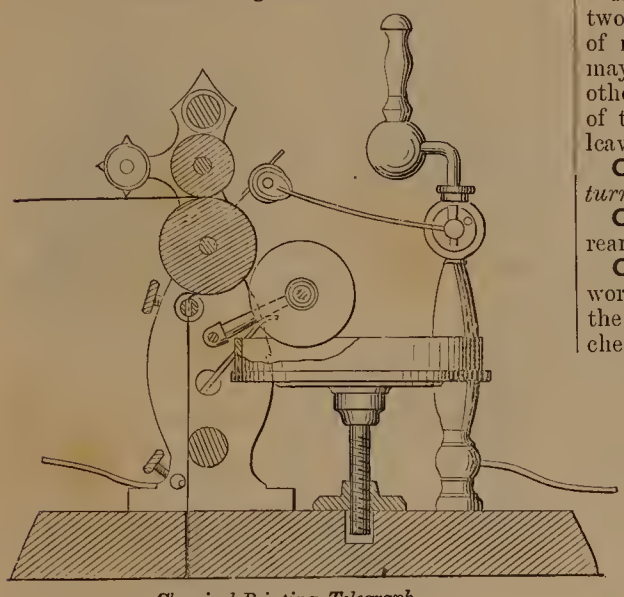
Chem'i-cal Ap'pa-ra'tus. The name *chemistry* indicates literally "Egyptian art," the art of the black land; for Plutarch knew that the Egyptians called their country Χημεία, from the black earth. The inscription on the Rosetta stone has *Chmi*. See STILL, BALANCE, HYDROMETER, etc., in their specific alphabetical places.

Chem'i-cal Fur'nace. A small furnace for laboratory uses. See STOVES AND HEATING APPLIANCES.

Chem'i-cal Print'ing-tel'e-graph. An apparatus for printing symbols upon prepared paper by means of electro-chemical action; as, for instance, by an iron stylus on paper prepared with a solution of yellow cyanide of potassium. In the example, the paper strip, just before passing under the recording-needle, is moistened by contact with a wheel revolving in a reservoir of suitable liquid. See ELECTRO-CHEMICAL TELEGRAPH. (Fig. 1266.)

Chem'ick-ing. (*Bleaching.*) The process of steeping goods in a dilute solution of chloride of lime in stone vats, the liquor being continuously pumped up and straining through the goods until the

Fig. 1266.



Chemical Printing-Telegraph.

action is complete. This precedes the *souring* which sets free the chlorine. See BUCKING KIER.

Che-min' des Rondes. (*Fortification.*) A beam at the foot of the exterior slope, sometimes masked.

Che-mise'. 1. (*Masonry.*) A wall that lines the face of a bank. A *breast-wall.*

2. A French name for an under-garment; from the Spanish *camisa*, a shirt; this from the Arabic *kamis*, which is from the Sanscrit *kschauma*, linen. The garment, its name, and the cotton from which it is now made, were introduced into Europe by the Spanish Saracens.

Chem'i-type. (*Engraving.*) A somewhat general term which includes a number of relief processes by which a drawing or impression from an engraved plate is obtained in relief, so as to be printed on an ordinary printing-press.

Cover a zinc plate with *ground*, and etch the design; bite in in; remove the ground; fill the lines with fusible metal, and scrape down to the zinc surface. Bite the plate with aqua-fortis, which will cut away the zinc and leave the fusible metal salient to be printed from by the ordinary press.

Che-nille'. A round fabric or trimming, made by uniting with two or more sets of warps, either by weaving or twisting, a fine filling or weft, which is allowed to project beyond the warps. This filling is cut at its outer edges, and the fabric is then twisted, assuming a cylindrical shape with weft projecting radially from the central line of warps.

Che-nille' Car'pet. The chenille carpet is soft and beautiful, but costly. In making it, the warp-threads are stretched out horizontally, as in a common loom, and the weft is thrown in by a shuttle; but this weft consists of chenille, instead of mere yarn, and when the weaving is completed, the loose, colored threads of the chenille are combed up and made to appear at the surface, where they are cut and sheared to a state of velvety softness. The pattern is dyed in the chenille itself, nothing appearing at the surface of the carpet except the ends of the chenille fringe.

Che-nille'-ma-chine'. In one form of French machine, the material is constantly reflexed upon itself, so that the article in the first instance presents a series of close loops, which must be cut, to give it a finish. Martin's machine, invented in 1851, produces in this way 2½ yards per minute.

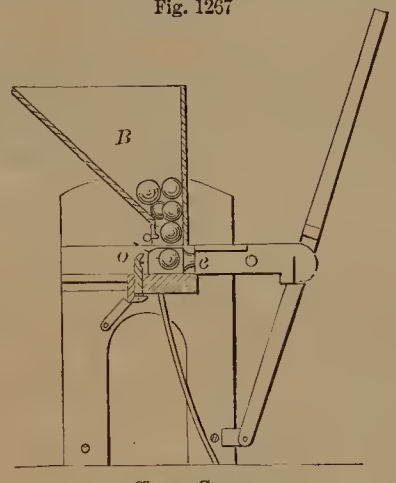
In Canter's machine the silk is confined between two strands, which are twisted together in the act of manufacture, and a rotatory knife is let down as may be required, to cut the pile, or silk, worsted, or other material which forms the ornamental surface of the chenille; or, by holding the knife aloft, to leave the pile uncut, to vary the effect.

Chep. A piece of timber forming the *sole* of a *turn-wrest plow.*

Cher'ry. A spherical bur. Used especially in reaming out the cavities of bullet-molds. See BUR.

Cher'ry-ston'er. A domestic implement which works by introducing a forked prong, which pushes the cherry-stone out of the pulp. In Fig. 1267, the cherries fall from the hopper *B*, and are thence pushed

Fig. 1267

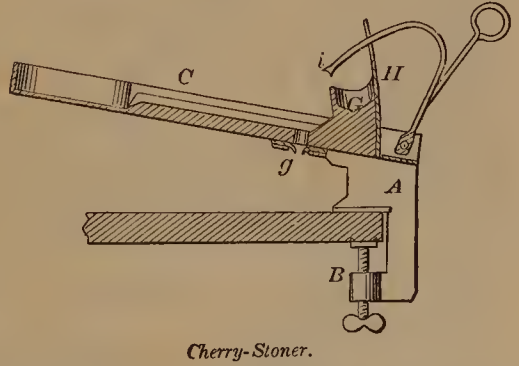


Cherry-Stoner.

in a gang by a plunger provided with a series of faces *c*, separated by plates and acting upon the cherries individually. Each stone is detained by a cruciform plate *o*, whose single post traverses a slot in the annular face of the plunger, which expels the fleshy portion.

In Fig. 1268, the cherries pass from the hopper *C* down inclined chutes to the cavities, where they are consecutively operated upon by the descending forked plungers *i*, which push the stones through the elas-

Fig. 1268.



Cherry-Stoner.

tic diaphragms *g* and return with the impaled fruit, which is stripped from them by plate *H*, and falls into an inclined discharging-trough *G*. *A B* is the clamp by which the cherry-stoner is attached to the table-leaf.

Chess. 1. A board-game which originated at an early date in India. The *chaturanga*, or primeval Indian game, was played by four persons, and the piece to be moved was indicated by throwing dice.

This was the game down to the sixth century A. D. From thence to the sixteenth century the mediæval game (the Shatranj) was practiced. In this two persons only played, and the element of chance was discarded.

Modern chess extends from the sixteenth century to the present time, the change from the mediæval consisting in the increase of the power of bishops and queen, and the introduction of castling.

The Emperor Akbar (1543–1605), surnamed Jalal-ud-din, "The Glory of the Faith," had a chess court in his palace at Futtehpore, nineteen miles from Agra on the Ganges. He was the greatest and the wisest of the monarchs of Hindostan, and, like Alfred of the West Saxons, seems to have been as versatile as he was grand. On the tesselated pavement of one of the court-yards of this splendid palace, the prince set his battle in array, with the mimic kings, queens, priests, and men-at-arms; his vizier and he marshaling the forces, and ordering the moves of the living pieces. With pretty girls for pawns, and beardless beings of epicene gender for priests and cavaliers, he probably came as near enjoying himself as any one can who has all he wants.

2. A flooring board of a military bridge. The *chesses* lie upon the *balks*, which are longitudinal timbers resting upon the *bateaux* or *pontons*. *Chessex.*

Ches'sel. The perforated wooden mold or vat in which cheese is pressed. *Chessex.* See CHESS.

Chess-tree. (*Nautical.*) A piece of oak fastened on the top-side of the vessel, for securing the main-tack to, or hauling home the clue of the main-sail.

Chest-bel'lows. The piston bellows.

Chest-lock. A mortise lock, inserted vertically into the body of a chest or box, the plate, which frequently has two staples, being let into the under sides of the lid. The bolt has a horizontal movement.

Chest-rope. (*Nautical.*) A long boat-rope, or warp.

Chest-saw. A species of hand-saw without a back.

Che-val'-de-frise. A bar traversed by rows of pointed stakes, and used to barricade an approach or close a breach. Called a *Friesland horse* because first used at the siege of Groningen, in that province, in 1658.

Che-val'-glass. A looking-glass of such size and so mounted as to exhibit the full figure.

Chev'er-il. Leather of kid-skin.

Che-ville'. The peg of a violin or similar stringed instrument.

Chev-rette'. (*Ordnance.*) A machine for raising heavy guns on to their carriages.

Chev'ron. 1. A bent bar, rafter-shaped, in heraldry, and the form adopted for a distinguishing mark on the coat-sleeves of non-commissioned officers.

2. A zigzag molding.

Chi-a'ro-os-cu'ro. 1. A drawing made in two colors, black and white.

2. (*Printing.*) A system of printing by successive blocks of wood which carry respectively the outlines, lighter and darker shades, etc. Practiced in Germany and Italy in the fifteenth and sixteenth centuries.

3. A term used by artists to describe the effect of light and shade in a picture.

Chick'en-coop. A house or inclosure for fowls, of more or less pretensions. In the example the coop is provided with a metallic open-work end-piece, provided with sliding doors connected together so as to be opened simultaneously. The broods are protected by closing these sliding-doors at night.

Fig. 1269.

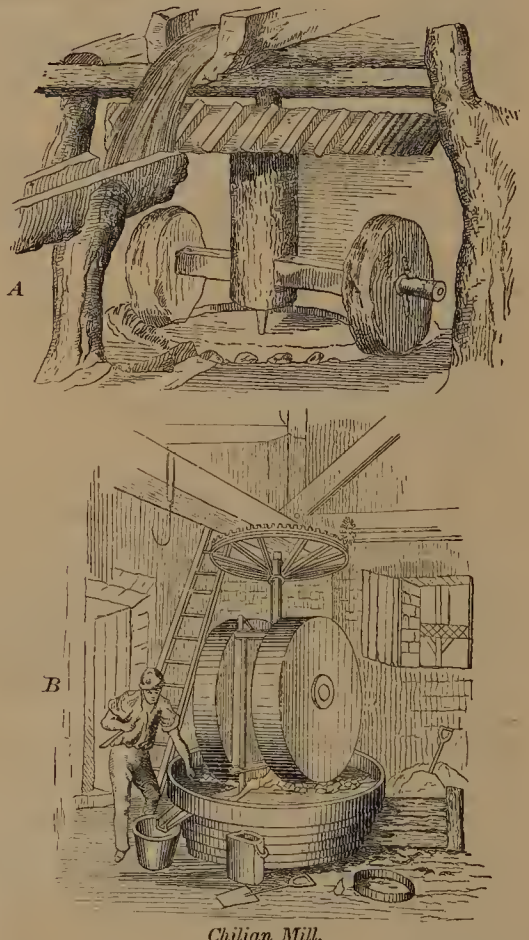
Chicken-Coop.

Chick'en-rais'ing Ap'pa-ra'tus. An *incubator* (which see).

Child's Car'riage. A small carriage adapted for children's uses, being drawn or pushed by an attendant.

Chil'i-an Mill. From time immemorial the ores of Mexico, Central America, and Peru have been worked, and the processes yet used in some of the more remote districts are rude and wasteful or exceeding slow. The Chilian mill and arrastra are specimens of the latter. *A* in the accompanying cut shows the adaptation of water-power as a motor for the primitive mill of Central America, the arrangements being of a massive and rude description. *B* shows a more modern form of the same device.

Fig 1270.



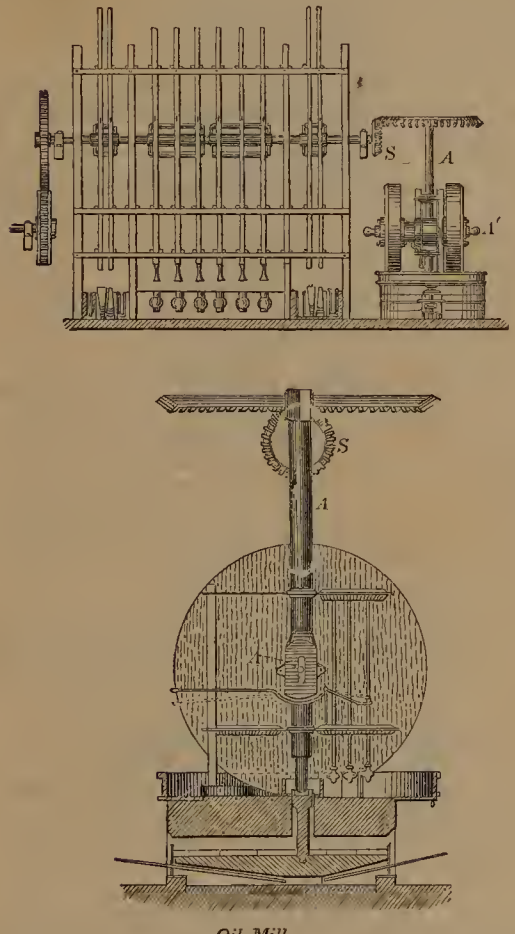
Chilian Mill.

The modern form of the Chilian mill in its application to the grinding of oleaginous seeds, nuts, kernels and fruits, is shown in Fig. 1271.

Each stone has a rotation on its horizontal axis *A'*, and also a rotation around the common, vertical axis *A*. The latter is driven by the pinion *S* and

bevel cog-wheel. A certain latitude of motion is allowed to the stones on their horizontal axis, and this passes through an oval aperture in the shaft *A*, so as to allow the shaft to rise and fall according to the quantity of material under the stones; the freedom of motion allowing the stone to pass over heaps of the material without straining. The bed-stone is supported on a foundation of masonry, and has raised inner and outer borders to keep the material from falling off. The grain is collected in the paths of the stones by scrapers, which partake of the motion of the central post, one scraper gathering the magma from the outlying parts and placing it in the track of one stone while the other scraper draws it so as to be crushed by the other stone. The stones are placed at different distances from the vertical shaft, so as to give them a wider track of usefulness. The inner one is two thirds of its width

Fig. 1271.



Oil-Mill.

nearer to the shaft, so that their tracks lap a little. When the crushing is completed, another adjustment of the scrapers transforms them into clearers, and they carry outwards the material, which then falls through an open part of the hoop, and is collected in a receptacle whence it is shoveled into bags ready for the press.

The Chilian mill, so called (also known as the "*Trapiche*"), is as old as Herodotus, at least. It was used by the Phœnicians for mashing olives. See OIL-MILL.

Chill. A piece of iron introduced into a mold so as to rapidly cool the surface of molten iron which comes in contact therewith. Cast-iron, like steel, is hardened by rapid cooling, and softened by the prolongation of the cooling process. The extreme in the former direction gives *chilled iron* the hardness of hardened steel; the extreme in the direction of softness is obtained by prolonging the heat, abstracting the carbon from the cast-iron, reducing it to a nearly pure crystalline iron. See MALLEABLE IRON.

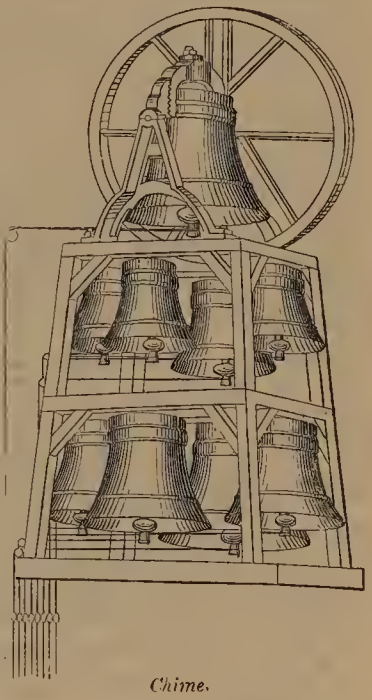
The chilled cast-iron plowshare has a hard undersurface, and the top wears away, leaving a comparatively thin edge of hardened metal. This resembles the natural provision in the teeth of rabbits, squirrels, and other rodents, whereby the enamel remains in advance of the softer portion of the tooth, keeping a sharp edge.

Chilled castings are used for axle-boxes, iron wheel-hubs, rolls for iron-rolling mills, plowshares, and mold-boards, stamp-heads, heavy hammers, and anvils for some kinds of work, and in many other instances.

Chill-hard'en-ing. A mode of tempering steel-cutting instruments, by exposing the red-hot metal to a blast of cold air.

Chime. 1. A number of bells attuned to each other in diatonic succession. A *peal* consists of three or more bells in harmonic succession, which may be rung successively or simultaneously, but will not admit of a tune being played upon them. Thus a set embracing the eight notes of the common scale will constitute a chime, while a set upon the *first*, *third*, *fifth*, and *eighth* of the scale would be a peal. The smallest number of bells that can be said to constitute a chime is five, but the number may be increased indefinitely. The usual number is at least nine, which number embraces the eight notes of the natural scale, with the addition of a flat seventh.

Fig. 1272.

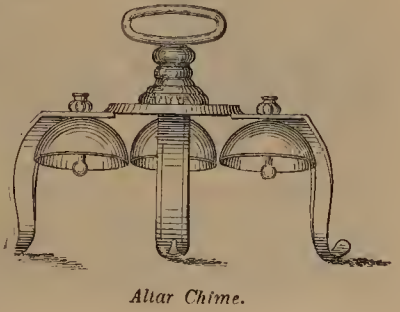


Chime.

The illustration shows a chime in a Philadelphia church; nine bells, key of D, weight 12,798 pounds.

A set of three small bells mounted in a stand for ringing by hand, used in the Roman Catholic church service, is also called a chime, or *altar chime*.

Fig 1273.



Altar Chime.

A new carillon of bells manufactured in France and mounted in Buffalo, is 43 in number. They are worked by a key-board, and

discourse beautiful music. Attached to the carillon, and independent of the key-board, is a clock, which, by delicate machinery, is made to play any arranged tune on the bells by means of 123 hammers adjusted on the outside of the bells. The clock also strikes the hours, half-hours, and quarters.

Apparatus for ringing chimes is said to have been first made at Alost, in the Netherlands, in 1487. Scheppen of Louvain is celebrated as a chime-player, and performed violin music. Potthoff, the chime-player of Amsterdam, 100 years since, played pianoforte music with facility. Each key required a force equal to two pounds' weight.

Chimes on a small scale, rather as toys and scientific instruments, have been rung by electricity; a clapper or suspended ball being made to rotate around a central axis, striking in succession the bells which are arranged in a circle beneath.

2. An arrangement of bells and strikers in an organ or musical box, operated in harmony with the reeds, pipes, or tongues, as the case may be.

3. (*Coopering.*) The rim of a cask or tub, formed by the ends of the staves, which project beyond the head.

Chime-bar'rel. (*Horology.*) A prolongation of the rim of a striking-wheel, which is furnished with pins, like the barrel of a musical box, the pin lifting the tails of the hammers, which are set on one axis and strike their respective bells when set in motion.

Chim'ming. (*Metallurgy.*) The operation of agitating ore in a *keeve* or tub, by means of a stirrer, the *keeve* being inclined at an angle of 45°. The ore and water being placed in the tub, the whole mass is violently stirred until it all partakes of the gyration, when the stirring is stopped and the heavier particles first reach the bottom. The different strata of particles are then sorted according to quality. See KEEVE.

Chim'ney. The open hole for the emission of smoke is referred to in Herodotus, VIII. 137: — "Now it happened that the sun was shining down the chimney into the room where they were; . . . . the boy who had a knife in his hand made a mark with it round the sunshine on the floor of the room."

The passages from the Greek authors, which have been cited as showing the use of chimneys, do not prove their existence, but generally refer to a mere opening at which the smoke escaped.

Here, however, is one fair notice of a chimney: —

"*B.* Don't cut me, cut the meat, —
Boys, bring the kid.
A. Is there a kitchen near?
B. There is.
A. And has it got a chimney too?
For this you do not say.
B. It has a chimney.
A. But if it smokes, it will be worse than none.
B. The man will kill me with his endless questions."

From "The Woman sitting up all Night," a play by ALEXIS; quoted by ATHENÆUS in the "Deipnosophists," A. D. 220.

One mode of warming is noticed by Seneca and Pliny, and consisted in an arrangement of pipes to convey hot air from an underground apartment into which red-hot coals were occasionally thrown. The intention was to avoid the smoke incident to the burning of the fuel before it attained the red-hot condition. In the greater number of houses the fuel was burnt in the room and the smoke escaped as it could, at the nearest door, window, or an opening in the roof. In the hot-air arrangement described, the caloric current was conveyed by pipes to the room, and discharged at a mouth which was often ornamented with a dolphin's or a lion's head, according to fancy, and which could be opened or shut at pleasure.

The Emperor Julian, when at Paris, complained of the rigor of the climate and the inefficient means for mitigating it, even in the best apartments. He disliked the braziers, and it would seem that no arrangements, such as described by Seneca, and suggested by the hypocaust of the baths, was at hand. See HYPOCAUST; HEATING APPARATUS.

Vitruvius does not mention chimneys. Winckelmann states that no traces of them are found in Herculaneum, where the people warmed themselves by fires in braziers placed on the floor of the apartment, as did Alexander the Great — according to Plutarch.

In Pompeii, chimneys are seen in connection with bath-rooms and bake-houses, but none in private dwellings.

Palladio only mentions two chimneys, which stood in the middle of the rooms, and consisted of columns, supporting architraves whereon were placed the pyramids or funnels through which the smoke was conveyed. Scamozzi mentions only three in his time, placed similarly.

We learn from Fletcher — "Notes from Nineveh" — that the houses in Mosul, on the Tigris, are not always provided with chimneys, although the weather is occasionally very severe. They use a round brazen vessel, with two rings attached to the sides, by which it is conveyed from one room to another. Mosul is termed by travelers the "Modern Nineveh," and the apartments of the old palace which once stood in the vicinity were no doubt similarly heated. Hosea xiii. 3, speaks of the smoke escaping from the chimney (a hole in the roof), and makes it an emblem of instability.

There are no chimneys or fireplaces in the houses of the Japanese. In the center of the common sitting-room there is a square hole lined with tiles and filled with sand, in which a charcoal fire is kept burning, and a teakettle is supported above by a tripod. A superior class of houses are warmed by braziers placed on lacquered stands. Holes in the roof and walls allow the smoke to escape. Wood, in its natural state, is but little used as fuel.

Travelers tell us that even now in Rome, which has a humid and raw atmosphere at times, the mode of warming is by chafing pans and portable charcoal furnaces, rather than by the generous fire of a grate or furnace.

Down to the thirteenth century, the people seem to have been generally destitute of chimneys. In the Middle Ages people made fires in their house in a hole or pit in the center of the floor, under an opening formed in the roof; and when the family laid down for the night, — for it can hardly be said they went *to bed*, — the hole was closed by a *cover* of wood. The laws of the feudal ages (*couvre-feu* of the French; curfew-bell of the English), ordered that such fires should be extinguished at a certain time in the evening. William I. introduced this law into England in 1068, and fixed the *ignitegium* at seven in the evening. The law was abolished by Henry I. in 1100.

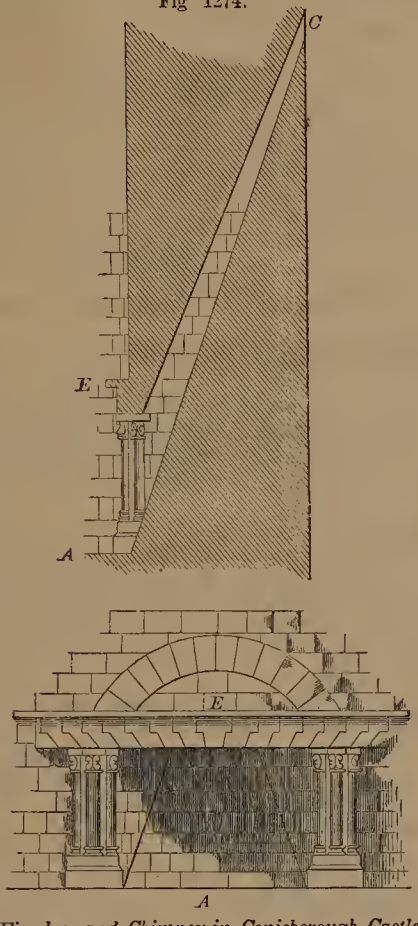
The curfew-bell also answered as a vesper-bell, calling the people to prayers. Pope John XXIII. ordered three *Ave-Marias* to be repeated at the hearing of the ignitegium. Pope Calixtus III. ordered the bell to be rung at noon also, to drive away a dreadful comet and the Turks. In due time the comet left, by which the faith of the people in bells was much strengthened, no doubt. The Turks, under Mahomet II., who had captured Constantinople a few years previously, were, however, long the bane of that corner of Europe, and are yet.

We find distinct notices of chimneys about the middle of the fourteenth century, at Venice, Florence, and Padua.

Francesco de Carraro, lord of Padua, came to Rome in 1368, and finding no chimneys in the inn where he lodged, because at that time fire was kindled in a hole in the middle of the floor, he caused two chimneys, like those which had been long used in Padua, to be constructed and arched by masons and carpenters whom he had brought along with him. Over these chimneys, the first ever seen in Rome, he affixed his arms, which were remaining in the time of Gataro (the narrator), who died of the plague in 1405.

Among the earliest English chimneys of which we have any knowledge is that of the large fire-hearth in the great guard-room of Conisborough

Fig 1274.



Fireplace and Chimney in Conisborough Castle.

Castle, erected in or near the Anglo-Saxon period. The mantel is supported by a wide arch, with two transom stones running under it; the back of the fireplace, where it joins the hearth, is in a line with the walls of the room, and the recess at the mantel is formed by the back of the fireplace sloping outwards, as it rises into the thickness of the wall, until it reaches a loophole on the outside, where the smoke finds an exit. The cut shows an elevation and a section of this fireplace, in which *A* is the floor of the room, *E* the mantel, and *C* the loop-hole.

In other castles erected about the same period, the hearth was formed in the thickness of the wall, and the conical smoke-tunnel ended in a loop-hole, as at Conisborough Castle.

Winwall House, in Norfolk, England, is of the Anglo-Norman period, has recessed hearths and flues rising from them, carried up in the external and internal walls. It was built in the twelfth century. Rochester, Kenilworth, and Conway Castles, Great Britain, show chimneys similar to that in Conisborough Castle.

A chimney in Bolton Castle, erected in the reign of Richard II., 1377–1399, has a chimney thus described by Leland: —

"One thynge I muche notyd in the hawle of Bolton, finiched or kynge Richard the 2 dyed, how chimeneys were conveyed by tunnels made on the syds of the walls betwyxt the lights in the hawle, and by this means, and by no covers, is the smoke of the harthe in the hawle wonder strangely conveyed."

In the old palace at Caen, which was inhabited by the Conqueror while he was Duke of Normandy, the great guard-chamber contains two spacious recessed fire-hearths in the north wall, still in good preservation, from which the smoke was carried away in the same manner as in the above examples.

The opening into the room is the *fireplace*.

The floor of the *fireplace* is the *hearth*.

The paved portion in front of the hearth is the *slab*.

At the back of the fireplace is the *fire-back*.

The flaring sides of the fireplace are the *covings*.

The vertical sides of the opening, a part of the wall of the apartment, are the *jambs*.

The *chimney-piece* is the ornamental dressing around the *jambs* and *mantel*.

The entablature resting on the latter is the *mantel*.

The *mantel-shelf*, or *mantel-piece* rests thereupon.

The whole hollow space from the fireplace to the top of the wall is the *funnel*, or *chimney-hood*.

The contracting portion of the funnel is the *gathering*.

The narrowest part is the *throat*. The throat is closed (at times) by a *damper*.

Above this is the *flue*.

The wall above the mantel against the flue is the *breast*.

The chimney above the roof is the *shaft*.

This, in England, is usually surmounted by a *chimney-pot*. And that frequently by a *hood*, *vane*, or *cowl*.

A cluster of chimneys is a *stack*.

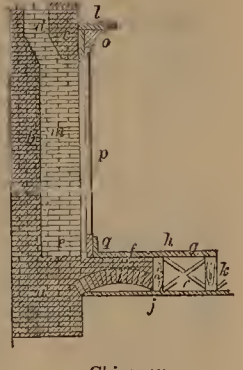
A *chimney-board* closes the fireplace in summer.

A *ciper-tunnel* is a false chimney placed on a house as an ornament or to balance things.

Fig. 1275 illustrates the various parts of a fireplace and chimney.

a, wall.
b, back.
c, breast.
d, flue.
e, hearth.
f, slab.
g, floor.
h, mitered border.
i, brick-trimmer.
j, ceiling.
k, joists.
l, mantel-shelf.
m, reveal or coving.
n, throat.
o, mantel.
p, jamb.
q, plinth.
r, bridging.

Fig. 1275.



Chimney.

The chimney at the Port Dundas Works, Glasgow, is the tallest chimney and one of the highest masonry structures in existence. In Europe there

are only two church steeples, those of the Strasburg Cathedral and of St. Stephen's Church, in Vienna, which, by a few feet, exceed the hight of this chimney, and the great Pyramid of Ghizeh was — but is not now — the only other human erection exceeding this great chimney in hight. The dimensions of this chimney are: — Total hight from foundation, 468 feet; hight above ground, 454 feet; outside diameter at the level of ground, 32 feet; outside diameter at the top, 12 feet 8 inches; thickness at ground level, 7 bricks; thickness at the top, 1½ bricks. The internal diameter at the base is 20 feet, and it gradually contracts toward the top to 10 feet 4 inches diameter. The section is circular throughout. The batter is straight, and it has no cap.

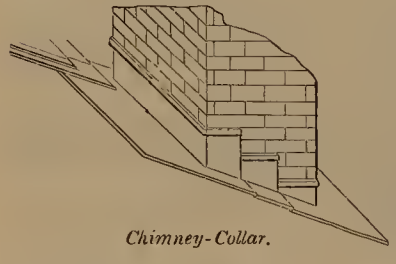
During its erection it underwent the operation of straightening by sawing the mortar joints. The mortar in the newly built portion of the work being still soft and plastic, the pressure of the wind caused a lateral deflection of the column, amounting to 7 feet 9 inches from the vertical at the top. The whole structure was thereby endangered, and in order to restore its stability, it was necessary to bring it back to the vertical line. This was safely accomplished by sawing away the mortar on the bowing side at selected points, so as to cause the chimney to settle back again and resume the perpendicular.

A wrought-iron chimney, 196 feet high and six feet seven inches in diameter, has just been erected in Pittsburg. Another is to be put up 275 feet high. The first was riveted together in a horizontal position, and then lifted to the perpendicular by a crane. The other is made upright, the plates being riveted by means of a scaffolding running up inside.

Chim'ney-cap. An abacus or cornice forming a crowning termination for a chimney.

A device to render more certain the expulsion of smoke, by presenting the exit aperture to leeward, or by a rotatory device. See COWL.

Fig. 1276.



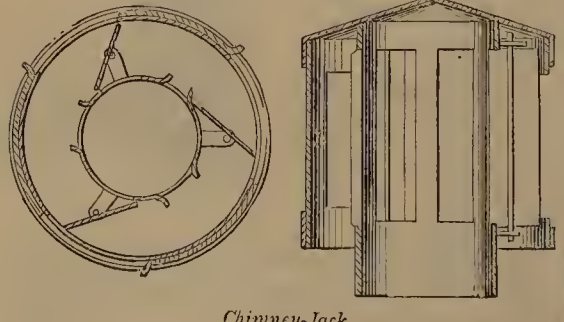
Chimney-Collar.

Chim'ney-col'lar. A device to prevent the leakage of rain around a chimney-stack where it protrudes through a roof. The slates or shingles lie upon the slanting plates, and upright plates lie closely against the bricks.

Chim'ney-hook. A hook suspended in a chimney from which to hang pots over the fire.

Chim'ney-jack. A rotating chimney-head. A form of *cowl*. In the example, the chimney-head has segmental sliding doors, within which are pivoted plates which deflect the currents passing through the side openings of the chimney.

Fig 1277.

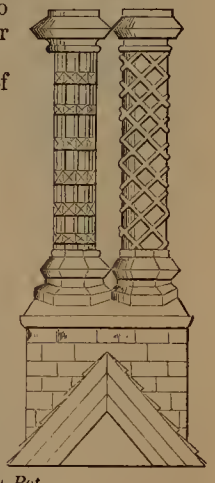


Chimney-Jack.

Chim'ney-piece. The ornamental frame round a fireplace; consisting of jambs and mantel.

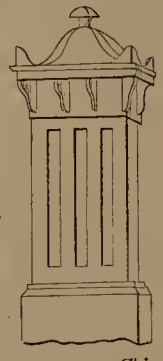
Chim'ney-pot. A tube of pottery or sheet-metal to extend a flue above the chimney-shaft. They are sometimes ornamental, and made to agree in design with the character of the building.

Fig. 1278.



Chimney-Pot.

Chim'ney-shaft. The part of a chimney above the roof.



Chim'ney-sweep'er. Invented in England by Smart, 1805, to supersede the climbing boys, who were so cruelly treated. A brush of rattan is fixed on the end of a rod which consists of jointed sections of cane, with a rope running down throughout the length of each section.

Chim'ney Top. 1. A chimney-cap or a cowl. See COWL.

2. (*Music.*) In organ building: a metallic mouth-pipe whose otherwise closed upper end has an open tube of small dimension, which allows a part of the air to escape and has the effect of sharping the note. See MOUTH-PIPE.

Chim'ney-valve. A device of Dr. Franklin for withdrawing the foul air from an apartment by means of the upward draft in the chimney. In its simplest form it consists merely of a metallic frame fitted in an aperture in the chimney and having a suspended flap opening inwardly to the chimney which allows a current to pass in that direction, but shuts off a down-draft into the room.

Chi'na. A fine variety of pottery, now known as porcelain, originally introduced from the country whose name it bore for some centuries. The term porcelain is Portuguese. See PORCELAIN.

Chi'na-blue Style. A mode of calico-printing in which indigo-blues are printed on the cloth and fixed by baths of salts of iron and of alkali.

Chi'na-grass Cloth. (*Fabric.*) A fine fabric made from the fiber of an Indian nettle, the *Rheea* or *Ramie*.

Chin-chil'la. (*Fabric.*) A heavy cloth for women's winter cloaking, with a long-napped surface rolled into little tufts in imitation of chinchilla fur.

Cni'né. (*Fabric.*) *a.* A lady's dress goods made with printed or dyed cotton or silk warps, afterwards woven. A mottled effect is produced.

b. A fabric in which a mixture of colors is produced by a double thread formed of two smaller threads of different colors twisted together.

Chine'ing-ma-chine'. (*Coopering.*) A machine to chamfer the ends of staves on the inner surface, and form the chine.

Chi-nese'-bal'ance. A form of the *steelyard* having four points of suspension and as many quadrated sides to the weight-arm of the lever. See STEELYARD.

Chi-nese'-cap'stan. A differential hoisting

or hauling device, having a vertical axis, and therein only differing from the *differential windlass* (which see).

Chi-nese'-fire. A pyrotechnic composition consisting of gunpowder, 16 ; niter, 8 ; charcoal, 3 ; sulphur, 3 ; cast-iron borings (small), 10.

Chi-nese'-wind'lass. A differential windlass in which the cord winds off one part of the barrel and on to the other, the amount of absolute lift being governed by the difference in the diameters of the respective portions.

It is a good contrivance in the respect that great power may be attained without making the axle so small as to be too weak for its work. See DIFFERENTIAL WINDLASS.

Chin'ka. The single cable bridge of the East Indies, upon which traverses a seat in the shape of an ox-yoke.

Chinse. (*Nautical.*) To stop a seam temporarily by crowding in oakum with a knife or chisel. A slight calking.

Chins'ing-i'ron. (*Nautical.*) A calker's edge-tool or chisel for chinsing seams.

Chin-strap. (*Saddlery.*) A strap connecting the throat-strap and nose-band of a halter.

Chintz. A cotton cloth gayly printed with designs of flowers, etc., in five or six different colors. It was a favorite in the time of Queen Anne, long before cotton prints became cheap.

> — "let a charming chintz and Brussels lace
> Wrap my cold limbs and shade my lifeless face."

The English Parliament had prohibited the burial of corpses in cotton or linen goods, intending to improve the demand for woolens. The young lady is supposed by Pope to express her disgust at donning the unfashionable fabric even for burial.

Swift says : — "Chintzes are gaudy and engage our eyes."

The name, being highly respectable, has since been applied to goods lacking the graceful and artistic character of the genuine article.

The chintzes of the Coromandel coast were celebrated in the time of Marco Polo, thirteenth century. They are mentioned also by Odoardo Barbosa, a Portuguese, who visited India soon after the passage of the Cape of Good Hope by Vasco da Gama : — "Great quantities of cotton cloths admirably painted, also some white and some striped, held in the highest estimation."

Chip. (*Nautical.*) A piece of wood of the shape of a quadrant, of 6 inches radius, and ¼ inch thick, placed on the end of a log-line. The chip is loaded at the circular edge so as to float upright, about two thirds being immersed in water. The knotted log-line is wound on a reel, and the *chip* or *log* being thrown overboard catches in the water and remains about stationary there, while the cord unwinds as the vessel proceeds. The number of knots passing the seaman's hand while the sand in the half-minute glass is running out, indicates the number of knots or nautical miles per hour of the vessel's speed. See LOG.

Chip-ax. A small, single-handed ax used in chipping or listing a block or scantling to a shape approximating that to which it is to be dressed.

Chip'ping-chis'el. A cold chisel with a slightly convex face and an angle of about 80° ; used in removing a scale of iron, hardened by contact with the damp mold in casting. The removal is a preparation for finishing with the file or other tool, the chilled iron being very destructive of files.

Chip'ping-ma-chine'. A planing-machine for cutting dye-woods into chips. See BARK-CUTTING MACHINE.

Chip'ping-piece. (*Founding.*) *a.* An elevated cast (or forged) surface, affording surplus metal for reduction by the tools.

b. The projecting piece of iron cast on the face of a piece of iron-framing, where it is intended to be fitted against another.

Chi'ra-gon. A writing-machine for the blind. A *cecograph.*

Chi'ro-plast. An instrument, or *hand-director*, as its name indicates, for training and exercising the hands, for giving them facility and command in playing music. It was invented by Professor John Bernard Logier, a native of Germany, and resident of London, England, who died about 1852. Patented in England about 1812.

It consists of the *position-frame*, to keep the hands from wandering ; the *finger-guides*, two movable brass frames each having five divisions ; and the *wrist-guide*, to preserve the proper position of the wrist.

The *gamut-board* was also a portion of the apparatus, its use being to indicate the notes, it being fitted closely to the finger-board.

The inventor was a distinguished contrapuntist and theorist, — a musical luminary.

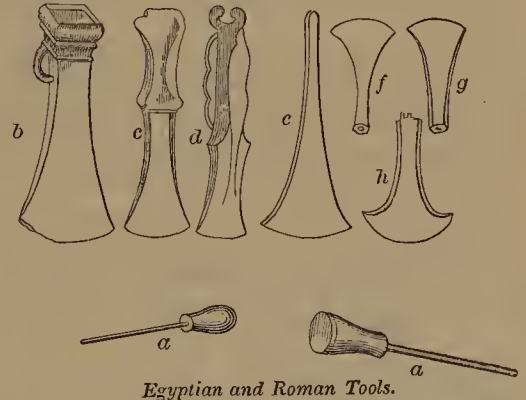
Chis'el. An edged tool for cutting wood, iron, or stone. It is operated by striking its upper end with a hammer or mallet or by pressure.

Mr. Burton found at Thebes, and deposited in the British Museum, a carpenter's basket and a kit of tools which have survived their owner some thirty centuries. The art of joining boards by dovetailing and by dowcling was practiced in Egypt as long ago as Osirtasen, 1706 B. C. The dowels were pinned in place by thin wooden pegs. Glue was also employed by them. See VENEERING.

The chisels of early Egypt (*a a*, Fig. 1279) were of bronze, the handles of tamarisk. In some cases the blades were attached by thongs to the handles.

One of the commonest tools or weapons in the museums is the *celt*. This term is held to include

Fig. 1279.



Egyptian and Roman Tools.

numerous cutting-tools ; it is derived from the word *celtes*, an old Latin term for a *chisel*. Axes, hatchets, chisels, skin-scrapers, and other tools are assembled in these collections under the one name.

In the accompanying cut, *b* is a bronze socket-chisel, 6 inches long, found at Karnbrè, Cornwall, England. The ear or loop may have been for carrying it suspended from the girdle, but was probably for lashing it to a helve. See HATCHET, Figs. *c e*.

c and *d* are bronze chisels in the British Museum.

e has a round handle. It is 9 inches long, is of bronze, weighs 2 pounds 5 ounces.

f, *g*, and *h* are smaller tools, adapted to be used with the mallet or otherwise.

The chisels and gouges of the Tahitians when first discovered were of bone, generally that of a man's

arm between the wrist and elbow. The bone tools disappeared in a few years after the advent of the white man.

Stone chisels, pointed and wide bitted, also mallets of the modern form, are shown in the paintings of ancient Thebes. They were probably of hard bronze, though it is not to be doubted but that steel was known to the artificers of that wonderful nation. Iron and steel have perished with rust while bronze has survived, and articles of that metal abound in all the museums.

Fig. 1280.

Ancient Flint-Chisels and Sharpening Implements.

The Japanese chisels are light and small. The cutting parts of some are the size and shape of a section of half a dollar, the square side being the cutting edge, and a round metallic shaft connecting the convex side with a wooden handle.

The knife must be regarded as the primary tool, and the chisel is a strong knife sharpened and presented endways.

Holtzapffel, in generalizing on the subject, regards the chisel as a keen wedge, sometimes employed with quiet pressure, and at other times with percussion, the former including the plane bit, and the latter the ax and adze.

The chisel used as a turning-tool introduced the circulatory process, and the reversal of conditions constitutes the cutting-tool the mover and introduces the boring-tool.

Saws he regards as a multiplication of scraping-chisels, and the file as a suggestion from the saw.

The blades of shears and scissors act as chisels from opposite sides of the material, and the punch is a chisel with a circular edge, whose counterpart, if it have one, is an aperture whose margin answers as the opposing shear.

This is ingenious and somewhat satisfactory, and is to be expected of a man who makes the lathe and its cutting-tools the primary central cluster of the mechanical firmament. "It is good to be zealously affected in a good thing," said an able mechanic of yore.

James Watt, no mean judge, said that "the true inventor of the *crank rotative motion* was the man — who unfortunately has not been deified — who first invented the common foot-lathe."

See under the following heads : —

Astragal tool.
Bent gouge.
Blacksmith's chisel.
Bliud-slat chisel.
Boasting-chisel.
Bolt-chisel.
Bone-chisel.
Bur-chisel.
Calking-chisel.
Cant-chisel.
Carpenter's chisel.
Carving-chisel.
Center-chisel.
Chasing-chisel.
Chipping-chisel.
Chisel in marteline.
Cold chisel.
Cope-chisel.
Corner-chisel.
Cross-cutting chisel.
Cross-mouth chisel.
Dental chisel.
Diamond-point chisel.
Dog-leg chisel.
Double-chisel.
Drove-chisel.
Entering-chisel.
File-chisel.
Firmer-chisel.
Flat-chisel.
Flogging-chisel.
Framing-chisel.
Gouge.
Grafting-chisel.
Hardy.
Heading-chisel.
Hooked tool.
Ice-chisel.
Indented chisel.
Joiner's chisel.
Making-iron.
Marteline-chisel.
Mortise-lock chisel.
Mortising-chisel.
Paring-chisel.
Parting-tool.
Point.
Pruning-chisel.
Rod-chisel.
Round chisel.
Rouud-nose chisel.
Sash-chisel.
S-chisel.
Skew-chisel.
Slick.
Small chisel.
Socket-chisel.
Splitting-chisel.
Spoon-chisel.
Tang-chisel.
Tapping-gouge.
Tenoning-chisel.
Tongued-chisel.
Turning-chisel.

Besides those mentioned in the list are several varieties peculiarly adapted to the needs of certain trades ; such as : —

Blunt chisels.
Coachmaker's chisels.
Long-paring chisels.
Millwright's chisels.
Mortise-lock chisels.

Chis'el-draft. (*Masonry.*) In squaring the end of a stone block, one edge is chisel-dressed to a straight edge and forms a base for the determination of the other sides.

Chis'el in Mar'tel-ine. A *boasting-chisel* used by marble-workers. It is furnished with steel points at the end. See MARTELINE.

Chit. A small *frow* used in cleaving laths.

Chi-tar'ah. (*Fabric.*) A cotton and silk stuff made in Turkey.

Chlo'ri-na'tion. A process for the extraction of gold by exposure of the auriferous material to chlorine gas.

The process was first introduced by Plattner, a professor in the School of Mines, Freiberg, Saxony.

"The principle involved is the transformation of metallic gold, by means of chlorine gas, into soluble chloride of gold (the *aurum potabile* of the ancients), which can be dissolved in cold water, and precipitated in the metallic state by sulphate of iron, or as sulphide of gold by sulphureted hydrogen gas. The precipitate may then be filtered, dried, and melted with suitable fluxes to obtain a regulus of malleable gold." — RAYMOND.

The following conditions are necessary : —

1. The gold must be in a metallic state.

2. There must be no other substance in the charge which would combine with free chlorine.

3. The chlorine must have no impurities which would dissolve other metals or bases.

4. No reaction must be induced which would cause precipitation of the gold before the termination of the process.

The process with quartz and free gold does not involve roasting, but the latter process is necessary with ores containing sulphurets and arseniurets. In the chlorination process, the ore is sifted into a wooden vat lined with pitch, and having a false bottom beneath which the gas is admitted. The top is luted on and the gas admitted ; when the gas begins to escape at a hole of observation in the lid, it is the signal that the air is ejected and the hole is then closed. The gas is continually passed into the mass for say eighteen hours, according to the coarseness of the gold ; the cover is removed and water introduced, and the solution drawn off into

the precipitation vat. The gold is precipitated by sulphate of iron, the supernatant liquor decanted. The sediment is a brown powder which is filtered upon paper dried in an iron or porcelain vessel, smelted to a metallic regulus in clay crucibles, a little borax, salt, and nitrate of potash being used as fluxes. See Raymond's "Mines, Mills, and Furnaces," pp. 417 - 431.

Chlo-rom'e-ter. An instrument for testing the decolorizing or bleaching powers of samples of chloride of lime.

Ure's process consists in adding liquor of ammonia of a known strength, tinged with litmus, to a solution of a given weight of the chloride under examination until the whole of the chlorine is neutralized, which is known by the color being destroyed. From the quantity of ammonia consumed the strength of the sample is estimated.

The instrument is an inverted and graduated siphon-shaped tube with a closed long end, and a shorter open end. The tube being filled with mercury, a certain quantity is displaced by a wooden plug, say 10°. This space is filled with the solution of the chloride, which is then let up into the closed end of the tube by putting the finger over the open end and tipping the tube. Liquor of ammonia is now let up, and nitrogen is evolved equivalent to the chlorine present.

Chock. 1. (*Shipbuilding.*) *a.* A block, preferably wedge-shaped, driven behind the props of a cradle to prevent it from slipping on the ways before the ship is ready to launch.

b. A piece of timber, framed into the heads and heels of ship's timbers at their junctions to act as a lap to the joint, and make up the deficiency at the inner angle, as in the stem-piece and the main-piece of the head; in the dead wood, etc. See Stem.

2. A wedge-shaped block placed beneath and against the bilge of a cask to keep the latter from rolling.

3. A piece of wood by which the wheel of a carriage is prevented from moving forward or backward.

In the United States Ordnance Department two kinds are employed, the simplest form being triangular in section, while another description of chock is wedge-shaped and provided with a handle.

Choc'o-late-mill. Chocolate is a paste made from the roasted kernels of the *Theobroma cacao* (food for the gods), so called by Linnæus, who so much esteemed it. The beverage was advertised in London in 1657, as "an excellent West India drink called 'chocolate.'"

Fig. 1281.

Chocolate-Mill.

The roasted and crushed seeds of the cacao-nut tree are ground between two horizontal millstones, which are kept at a temperature of about 200° F., by means of a steam-jacket.

The nibs pass down from the hopper into the shoe, which is shaken by a damsel on the spindle of the runner so as to discharge the nibs into the eye which leads them to the space between the stones. The heat and friction liberates the oil, which is one third of the weight, and the cacao issues as a paste from the spout and is conducted to a second and similar mill where the stones are similarly heated but are closer set, so as to still farther reduce the paste. It is discharged from the second grinding in a liquid condition and is collected in a pan, where it hardens into a cake.

To enable it to form an emulsion with water, it receives additional substances. Sugar, honey, molasses, gum, starch, flour, rice, and arrow-root are adapted for this purpose. Spices and flavoring extracts are added for some markets.

Devinck's machine (English) is for wrapping chocolate in paper envelopes.

Choir-or'gan. (*Music.*) One of the three aggregated organs which are combined in an organ of large power. The other two are the *great*-organ and the *swell*. The great organ has its large pipes in front and its bank of keys occupies the middle position; it contains the most important and powerful stops. The *choir*-organ has its key-board below that of the *great*-organ, and contains stops of a light character and solo stops. The *swell* has its bank of keys the highest of the three, and has louvre boards which may be opened and shut by means of a pedal, so as to produce *crescendo* and *diminuendo* effects.

Choke-strap. (*Saddlery.*) A strap passing from the lower portion of the collar to the belly-band, to keep the collar in place when descending a hill or backing.

Chon-drom'e-ter. A steelyard for weighing grain.

Chon'dro-tome. (*Surgical.*) A knife specifically adapted to dividing cartilages.

Chop. The movable wooden vise-jaw of a carpenter's or cabinet-maker's bench.

Chop-boat. A Chinese lighter for transporting merchandise to and from vessels.

Chop-ham'mer. (*Metal.*) A cutting-hammer.

Chop'ness. A kind of spade (English).

Chop'per. An agricultural implement for thinning out plants in drills. It is used in England for turnips; in the United States, for cotton-plants. Cotton-seed is drilled in and comes up in a row; the cotton-chopper straddles the row and *chops* wide gaps, leaving the plants in hills. These are thinned out by hand.

Chop'ping-knife. A knife designed for chopping meat, vegetables, fruit, etc., upon a board, block, or in a bowl. Used on a domestic scale for cutting meat for mince, hash, sausage, etc. See Sausage-machine.

Chorl. The angle at the junction of the blade of a penknife with the square shank which forms the joint.

Cho-rob'a-te. The Greek level. See Level.

Cho'ro-graph. An instrument contrived by Professor Wallace, of Edinburgh. "To determine the position of a station, having given the three angles made by it to three other stations in the same plane whose positions are known."

The problem occurs frequently in maritime surveying, and is otherwise stated : —

"To construct two similar triangles on two given straight lines."

Chro-mat'ic Print'ing. The precursor of color-printing was the illuminated missal with its initial letters and borders, hand-painted in colors, and the playing-cards upon which the art of printing was first executed in Europe. See CARD.

Koster's *Speculum Humanæ Salvationes*, printed at Haarlem, 1440, has engravings on wood printed in different color from the body of the work.

Fust and Shœffer's Psalter, 1457, had initial letters and flourished lines printed in two colors, red and blue.

The art soon became common, and towards the end of the fifteenth century imitations of pen-and-ink sketches on a colored ground were made by celebrated artists. This was followed by drawings on blocks in regular sets for separate colors. Albert Durer engraved such blocks; Parmigiano, Titian, and Raffaelle made designs on blocks for the purpose.

Jackson started a paper-hanging factory at Chelsea, England, 1720–1754, the designs being printed in oil by wooden blocks. He appears to have been unsuccessful in some details and in the speculation.

The art was adopted and improved by a succession of persons in England and elsewhere; Skippe and Savage of the former, and Gubitz of Berlin, adding considerably to the eminence already attained.

Savage ground the various pigments of the painter into inks, and imitated water-color drawing successfully.

Whiting and Branston applied different colored inks to ornamental borders, and to notes, bonds, checks, etc., to prevent forgery.

Vizitelly and Branston, and subsequently Baxter, attained considerable excellence. See CHROMO-LITHOGRAPHY.

The invention patented some years ago by Mr. Charles Knight, of London, is a process whereby fac-similes of designs in four colors are produced on the same sheet before it leaves the press, by means of a revolving carriage or bed, upon which the blocks are secured. A mode of printing in four colors by means of turning the tympan with the sheet secured on it was somewhat less complicated than Mr. Knight's. The processes, however, necessitated the application of the four colored inks at every revolution and impression, and also involved considerable outlay for machinery.

In Carpenter's process everything is carried on in as straightforward a manner as in ordinary black printing. It may be thus briefly described : —

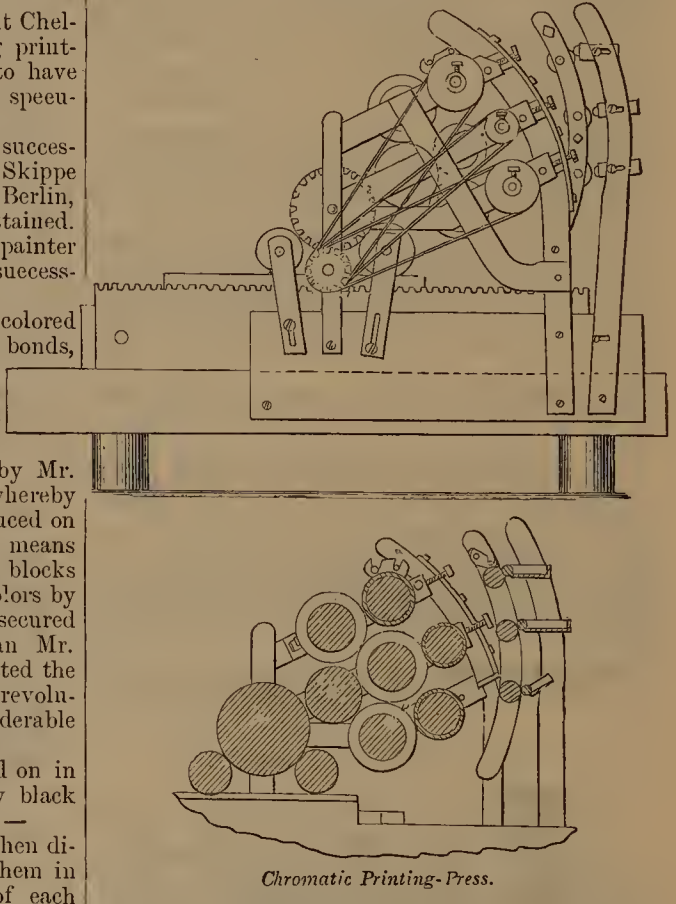
A form is set up by the compositor; he then divides it into four sections, and so imposes them in one chase that the same relative corner of each (whichever may be chosen) shall point towards the middle of the chase. It is then ready for the pressman. It requires *making ready* with points placed, according to the tact of the workman, in such position as may be deemed expedient, four points being sufficient in all, and these so placed that the sheet may be *pointed* when turned either to the right or the left hand. Should 1,000 copies be required, the 250 sheets are printed in the first color. They are then simply turned one quarter round in either direction and printed in the second color. The operation is repeated for the third color, and again for the fourth color. This produces 1,000 perfect impressions of four varieties, in which the colors are differently arranged.

Should the whole possible number of combinations of four colors — namely, twenty-four — be required, nothing more is necessary than, while the sheets are being worked in the second color, to turn a portion of their number into the third and fourth positions, — which produces three kinds of sheets or twelve single varieties, — and while working the third color take half of each of the three kinds and work them respectively in the second, third, and fourth positions, producing six kinds of sheets or twenty-four single varieties.

One inking apparatus is sufficient, and but one ink is spread at a time, passing over all of the forms at once. This has no artistic merit, unless mere blocks of color in given juxtaposition give opportunity for the exertion of taste in harmony or agreeable contrasts. It is not very different from printing in colored bands or lines of type of different colors.

One press prints in several colors from one form and at one impression by making the inking cylin-

Fig. 1282.



Chromatic Printing-Press.

der in parts and supplying the sections with the separate colors.

Adams, 1844, had a poly-chromatic press by which a number of colors were had at one impression by a series of separate inking fountains.

M'Kenzie, 1846; a series of sliding tympans and corresponding series of plates for the separate colors, which impressed the paper in succession, giving a varicolored result.

Weaver, 1851; an ink trough with perforated side and movable partitions, to give out inks of varying colors in lines or belts corresponding to the lines of type.

Babcock, 1854; a sheet carried on a revolving-platen to plates of successive colors.

Sweet, 1855 ; narrow distributing rollers carrying various inks and laying them in belts on the inking-roller.

Baker and Hill, 1863 ; a continuous sheet of paper is printed in two colors, by intermittent motion and successive exposure to two reciprocating platens carrying forms which receive their specific colors from their own set of inking-rollers.

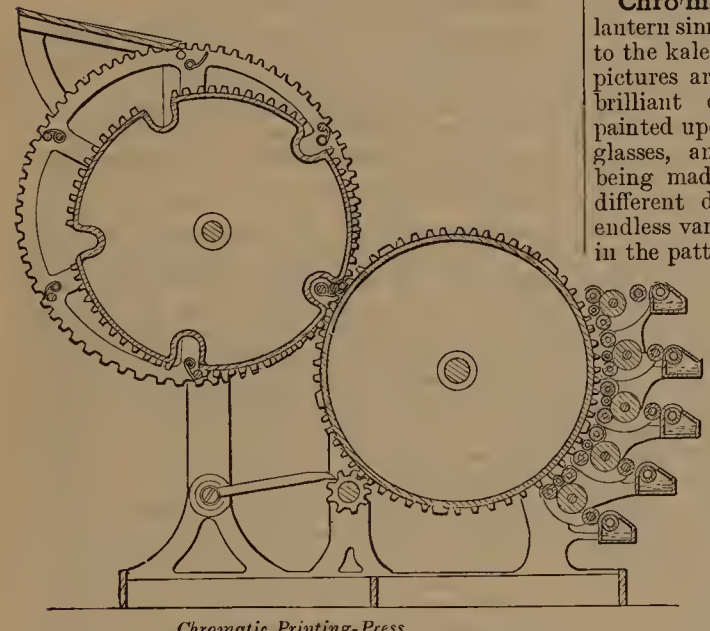
In Baylies and Wood, 1867, an oscillating frame carries a series of rollers which are brought in contact with fountain rollers of a series of fountains, each carrying different colored ink ; and the ink is communicated by another series of rollers to the segmental rollers, which in turn communicate the ink to a set of rollers common to all, and by which the type is inked in strips of various colors.

Slater, 1868 ; adjustable parallel inking-tables, each carrying its own color and furnishing it to a belt of corresponding width on the inking-roller.

Hunt, 1868 ; two forms, two impressions, ink-rollers with bands of colors.

In Dunk's press the sheet is held by the nippers while it receives the colors consecutively. There are two sectional cylinders revolving in unison, one

Fig 1283.



Chromatic Printing-Press.

of them carrying the required number of forms and the other a corresponding number of tympans, while a skeleton cylinder contains the nippers. The sheet is retained until fully printed, in the same nippers, which present it to the successive forms, from each of which it receives an impression in a different color.

The nipper shafts are journaled in wheels of larger diameter than the platen-cylinder, and the series of nippers outnumber the platen surfaces. The platen-cylinder has longitudinal recesses in its periphery, into which the nipper-shafts enter when in proximity to the form-cylinder, and by the larger diameter of the nipper-wheels the sheets are carried to a fresh surface at each revolution to receive the portion put on in fresh color. The inking-rollers are moved radially, to bring them to their proper type and to avoid the forms carrying another color, by cam-grooves which give the necessary motion to their journal-frames. The distributors have their reciprocation by the obliquity of their motive-wheel.

A valuable article on the colors and mixing of colors for chromatic printing may be found in Ringwalt's "Encyclopædia of Printing," pp. 109–112.

Printing in colors by a succession of colors superimposed as to those portions which are formed by the blending of tints is now done by the lithographic process. See CHROMO-LITHOGRAPHY.

Chro-mat'ic Ther-mom'e-ter. When the edge of a rectangular plate of glass is applied to a piece of heated metal, or other substance having a temperature different from that of the glass, and exposed to a beam of polarized light, colored fringes are developed. As the different tints depend on the different temperatures of the glass (which is supposed to be known), and that of the object to which it is applied, the color of the central fringe affords a means of inferring approximately the temperature of the substance. BRANDE.

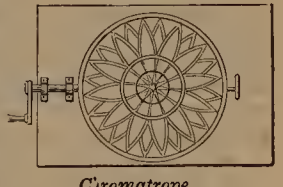
Chro-mat'ic Type. Type made in parts, which are inked of various colors and separately impressed, so as to unite into a variegated whole.

Chro'ma-scope. An instrument to exhibit the three optical effects of colors : —

1. The refraction of prisms and lenses.
2. The transmission of light through transparent media.
3. The reflection of speculums.

Chro'ma-trope. An arrangement in a magic-lantern similar in its effect to the kaleidoscope. The pictures are produced by brilliant designs being painted upon two circular glasses, and the glasses being made to rotate in different directions. An endless variety of changes in the pattern are caused by turning the wheel, sometimes slowly, then quickly, backward and forward.

Fig. 1284.



Chromatrope.

Chro'ma-type. (*Photography.*) A process in which the chromic acid is deoxidized. There are several modes of getting photographs by the chromine salts preferably the bichromate of potash.

Chro-meid'o-scope. The same as DEBUSCOPE (which see).

Chro'mi-om'e-ter. An instrument for determining the purity of water by its colorlessness. It consists of a glass tube of about a yard in length, closed at the end by a cork, and resting upon a white dish of porcelain. A green tinge is produced by minute algæ, a white opacity often by fungoid growths ; iron salts are indicated by a peculiar ochry color.

Chro'mi-um. Equivalent, 26.4 ; symbol, *Cr.* ; specific gravity, 6.81 ; is infusible except with an oxy.-pyd. blow-pipe. A grayish-white, brittle, hard metal, and combined with iron makes an alloy which resists all tools of steel, and is used for safes.

Compounds of chromium make beautiful pigments, and afford colors for glass, porcelain, and enamels.

Chro'mo. A contraction of chromo-lithograph adopted by Mr. Prang, of Boston, for reasons of brevity and as a trade-mark to indicate his productions. See CHROMO-LITHOGRAPHY.

Chro'mo-li-thog'ra-phy. The art of *color-stone drawing* as indicated by the three Greek words from which the name is derived. Color-printing was first applied in Europe to illuminating missals and printing playing-cards. (See CHROMATIC PRINTING.) The printing in a number of colors on wooden blocks or metallic plates was never success-

ful in an artistic point of view, inasmuch as the gradations of light and shade can only be expressed by lines of different thickness and by isolated dots, and do not admit of the complete blending of tints necessary to imitate the effect of an oil-painting. This was accomplished when the art of lithography was brought in aid. Baxter, 1803–1861, in England, produced some really pretty work by a combination of metallic plates and wooden blocks.

Lithography was invented by Alois Senefelder, who was born at Prague, 1771. (See LITHOGRAPHY.) In short, it may be described as drawing upon stone with a material which, when treated with certain chemicals, will take up the printer's ink when rolled up. Senefelder, even at that early date in the history of the art, spoke of the possibility of making fac-similes of oil-paintings. Storch and Kramer, of Berlin, successfully reproduced oil-paintings by this process (1840–1850).

In making chromo-lithographs, an outline drawing is made by tracing, and this is transferred to all the stones (one for each color), required to complete the picture; so as to secure exactness in the correlation of all parts on each stone. Within these outlines, and upon these different stones, the artist draws the different tints and colors. The number of stones, or plates, needed to complete the chromo, varies of course with the character of the picture to be reproduced. The highest number of stones, each representing one tint or color, employed by Prang upon the famous chromo called "Family Scene in Pompeii," was 43. An artist must have not only a high degree of skill in drawing, but must possess a fine feeling for and a thorough knowledge of color, and when a picture is presented to him he must be able to tell, approximately at least, what number of plates will be required to reproduce it, and in what order the tints and colors must follow each other. Furthermore, when drawing a new stone for a chromo in process of printing, he must not only be able to calculate what effect the tint or color in which the plate is to be printed will have upon the preceding tints or colors, — which latter will partly, or perhaps wholly, underlie the new color, — but he must also keep in view the tints and colors still to be added, which again in their turn will tend to modify or alter all those already printed. Thus it will be seen that the accusation sometimes leveled against chromos — viz., that they are merely *mechanical* productions — is wholly unfounded.

To treat it more in detail, it may be said that the drawing is made upon the slab with a sort of colored soap, which adheres to the stone and enters into a chemical combination with it after the application of certain acids and gum. When the drawing is complete, the slab is put on the press, and carefully dampened with a sponge. The oil color is then applied with a leathern roller. The parts of the slab which contain no drawing, being wet, resist the ink; while the drawing itself, being oily, repels the water, but retains the color applied.

In chromo, the first proof is a light ground-tint, covering nearly all the surface. It has only a faint, shadowy resemblance to the completed picture. It is in fact rather a shadow than an outline. The next proof, from the second stone, contains all the shades of another color. This process is repeated again and again; frequently, as often as thirty times. The number of impressions, however, does not necessarily indicate the number of colors in a painting, because the colors and tints are greatly multiplied by combinations created in the process of printing one over another. In twenty-five impressions, it is sometimes necessary and possible to produce a hundred distinct shades.

The last impression is made by an engraved stone, which produces a resemblance to canvas. On proper registering, the entire possibility of producing a picture at every stage of its progress depends. "Registering" is that part of a pressman's work which consists in so arranging the paper in the press, that it shall receive the impression on exactly the same spot of every sheet.

Chro'mo-type. 1. A sheet printed in colors. The modes are various, but the usual plan is to prepare a block for each color, or a form for each color, and to place the paper upon each in succession, the exact place being preserved at each impression by means of register pins or a similar device. See CHROMATIC PRINTING; CHROMO-LITHOGRAPHY.

2. A photographic picture produced in the natural colors. This was long sought by Niepce de St. Victor, and he announced his success even with yellow, but no way has been discovered of fixing these heliochromic pictures.

Chro'mo-scy'lo-graph. A colored picture produced by a succession of wooden blocks, each bearing its separate color. See CHROMATIC PRINTING.

Chro'no-graph. A time indicator.

Astronomical intervals are noted by pressing a key which makes one dot or puncture on a traveling strip of paper and another at the end of the observation. Such a time-paper becomes a record.

The racer's chronograph is one which deposits ink-spots on a traveling paper at the start and arrival of the horses.

Professor Glaesner, of the University of Liége, has a chronograph for the measurement of very minute particles of time by the application of electro-magnetism. To measure the velocity of a cannon-ball, a series of targets, consisting of hoops intersected by wires, are placed at given distances apart. The wires of each hoop communicate with a separate electro-magnetic apparatus, by which an iron pencil-holder is kept in an unvarying position by attraction so long as the circuit is not interrupted. Opposite and close to this pencil-holder there is a cylinder turning on its axis at the rate of four revolutions in a second. Its surface, which is covered with paper, is divided into five hundred parts by lines drawn parallel to its axis, so that each part represents one two-thousandth of a second. Its motion is effected by clock-work. Now, whenever the electric current is interrupted, the pencil-holder ceases to be attracted, and falls on the surface of the cylinder, on which its pencil, therefore, describes a line. Whenever the circuit is completed the pencil-holder is reattracted and leaves the paper. Let us now suppose a cannon-ball to be fired through all these targets, so placed, of course, as to lie in the path of the curve described by the missile. Each time it passes through one of the hoops it snaps asunder one of the wires; the circuit is consequently interrupted, the pencil-holder falls and marks the precise time of the passage. And so on, from target to target, each of which, as we have said, is connected with a separate apparatus. In this way both the space and the time employed in going over it being determined, the velocity, which is the ratio of time to space, is determined also to a fraction of one two-thousandth of a second.

Since 1848, the idea of recording astronomical observations by galvanic electricity has been put in successful operation by several individuals; Professor Hilgard of the coast survey, and Professor Hough of the Dudley Observatory, among the num-

ber. The chronograph of the latter prints with type the time of an observation. The professor thus describes it in brief. The plan is based upon the principle of using separate systems of mechanism for the fast moving type-wheel, and those recording the integer minutes and seconds, regulating each with electro-magnets controlled by the standard clock.

I. A system of clock-work carrying a type-wheel with fifty numbers on its rim, revolving once every second; one, two, or parts of two numbers being always printed, so that hundredths of seconds may be indicated. This train is primarily regulated to move uniformly by the Frauenhofer friction balls, and secondarily by an electro-magnet acting on the fast moving type-wheel, and controlled by the standard clock. This train is entirely independent, and can be stopped at pleasure, without interfering with the other type-wheels.

II. A system of clock-work consisting of two or more shafts, carrying the type-wheels indicating the minutes and seconds. The motion of this train is also governed by an electro-magnet, controlled by the standard clock, operating an escapement, in a manner analogous to the action of an ordinary clock; every motion of the escapement advancing the type one number. There are three type-wheels, indicating minutes, seconds, and hundredths of seconds. The integer seconds are advanced at every oscillation of the standard pendulum, and the minute, at the end of each complete revolution of the seconds wheel. The type-wheels are constructed of brass disks, around the circumference of which is soldered a strip of electrotype copper, holding sixty numbers.

The record is made by an armature hammer, the hammer being raised by weight and gear. The types are inked by small rollers. The paper fillet, two inches in width, is wound on a small spool, holding about forty feet, and drawn between two rollers, the same as a Morse register. Every time the hammer falls, the fillet is advanced about one quarter of an inch, by the action of an escapement driven by a weight. One spool of paper will hold about 1,200 observations, including the spacing for different objects. This same escapement is also operated by an electro-magnet, under the control of the observer, who, by pressing a key, is able to make spaces of any width between the prints.

The train carrying the minutes and integer seconds will run eight hours; the gear for elevating the hammer will deliver 800 blows; and the train for moving the paper fillet will go 1,200 times without winding. The fast moving train runs one hour and thirty-six minutes; but since this train can be stopped at pleasure, without changing the zero of the type, its comparatively brief running is not a serious inconvenience.

Chro-nom'e-ter. 1. A chronometer is a measurer of time, and this general meaning would include clocks, watches of all kinds, clepsydras, and some other devices, such as hour-glasses and the graduated candles of the beloved King Alfred. The term is, however, applied in a restricted sense to those having adjustments and compensations for the fluctuations of temperature. These have been adapted to the clock and to the watch: in the former the mercurial pendulum of Graham and the gridiron pendulum of Harrison may be cited; and in the latter, the expanding and contracting balance-wheel, depending upon the unequal expansion under changes of temperature of two different metals. With the improvements as adapted to instruments having a balance-wheel this article has to do.

The proposition to determine longitude at sea by means of a timepiece and observation for noon was made by Gemma Frisius, in 1530. The attempt did not fail for want of suggestions; Alonzo de Santa Cruz suggested to determine it by the variation of the compass-needle, and by sand-and-water timepieces, wheel-work moved by weights, and by "wicks saturated with oil," which were supposed to burn equal lengths in given periods of time.

During the sixteenth and seventeenth centuries the Spanish, Dutch, French, and English governments had offered rewards for an instrument which should determine longitude within a certain specified degree of accuracy. Sir Isaac Newton suggested the discovery of the longitude by the dial of an accurate time-keeper, and the Parliament of Queen Anne in 1714 passed an act granting £10,000 if the method discovered the longitude to a degree of sixty geographical miles, £15,000 if to forty miles, £20,000 if to thirty miles, to be determined by a voyage from England to some port in America.

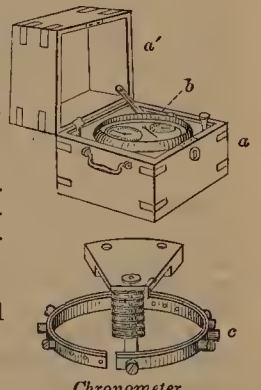
John Harrison, born in 1693 at Faulby, near Pontefract, in England, undertook the task, and succeeded after repeated attempts, covering the period 1728–1761. His first timepiece was made in 1735; the second in 1739; the third in 1749; the fourth in 1755, the year of the great earthquake at Lisbon. In 1758 his instrument was sent in a king's ship to Jamaica, which it reached 5″ slow. On the return to Portsmouth, after a five months' absence, it was 1′ 5″ wrong, showing an error of eighteen miles and within the limits of the act. He received the reward of forty years' diligence in instalments. He died in 1776.

Arnold made many improvements, and received government rewards amounting to £3,000.

Mr. Denison states that Earnshaw brought the chronometer to its present perfection.

The principles of the compensation balance are explained under COMPENSATION BALANCE (which see).

Fig. 1285.



Chronometer.

a a′, box and its lid.

b, chronometer suspended in gimbals.

c, chronometer balance.

Chronometers are known as *ship's* and *pocket*.

The rating of chronometers is usually conducted at government observatories.

The instruments are sent from the different watch-makers and received at stated periods. They remain the greater part of a year, their rates being noted daily by two persons. The best receive prizes and are purchased for the navy; others receive certificates of excellence; others are unrewarded. On their arrival in January, they are left to the ordinary atmospheric temperature for some months; their rates are taken under these conditions.

The apartment is then heated to a tropical temperature, and the rate taken.

They are then placed for a certain period in trays over the stove, and the rate taken.

They are then placed in a refrigerating chamber cooled by a freezing mixture, and the rate taken under this artificial arctic temperature.

Their capacity to stand these variations constitutes their value, and their actual range of exposure may be estimated at 180° — from the + 120° of

Aden and Fernando Po to the — 60° of the Arctic regions when frozen in the pack of ice and watching through the long, long night.

The two columns on which most reliance is placed in the schedule of performances are : —

a. "Difference between greatest and least rate."

b. "Greatest difference between one week and the next."

2. (*Music.*) An instrument to indicate musical time. A *metronome.*

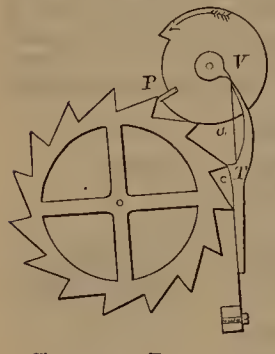
Chro-nom'e-ter-es-cape'ment. The chronometer-escapement was invented by Berthoud, and improved by Harrison, Arnold, Earnshaw, and Dent. It is the most perfect, delicate, and satisfactory in its operation, of all the escapements. It is also kept more carefully, at least in marine chronometers, as the gimbal-joint hanging enables it to maintain a constant position relatively to the horizon, and it is carefully guarded from jars.

There are several points which distinguish it from other escapements, and several which it has in common with one or more of the others.

The piece carrying the *detent-pallet* is a spring, and its motion to free the tooth of the escape-wheel is by the contact of a pin or tooth on the verge with a secondary spring attached to the former.

As the balance oscillates in the direction of the arrow, its tooth *V* comes in contact with the secondary spring *a*, and presses the lever, so that its tooth *T* is freed from the tooth of the escape-wheel. A ruby pallet *P* on the verge receives the impact of another scape-tooth, and the balance receives its impulse thereby. As the balance returns, its verge-tooth *V* presses past the spring without moving the lever which rests against a stop.

Fig. 1286.



Chronometer-Escapement.

The impulse is communicated from the scape-wheel direct to the balance-arbor, as it is also in the *duplex* movement, not as in the *lever* movement where a pivoted lever intervenes.

Arnold's chronometer-escapement is substantially the same ; a secondary spring attached to the spring-lever is made effective in vibrating the latter when moved in one direction, and in the other is so pliable as to allow the verge-tooth to pass freely. As just explained, the stroke which raises the spring-lever withdraws the detent from the tooth of the scape-wheel, and at the same time that this tooth escapes, another strikes a pallet on the arbor of the balance, and restores to the balance-wheel the force lost during a vibration.

The free movement of the balance is only opposed at one point during a complete oscillation.

Chro'no-met'ric Gov'ern-or. A device by which a time-measurer set to work at a prescribed and equable rate is made to regulate the motion of an engine. Invented by Wood and improved by Siemen.

Chron'o-scope. Invented by Professor Wheatstone in 1840, to measure small intervals of time. It has been applied to ascertaining the velocity of projectiles. In Pouillet's chronoscope, a galvanic current of very short duration makes a magnetic-needle deviate, the duration of the current being measured by the amount of deviation ; by this means as short a time as some thousandths of a second can be measured. Schutz's chronoscope was employed by the Ordnance Department at the experimental firings at Fortress Monroe. The apparatus, operated by electricity, is described as follows : — Two wire targets are placed, one about twenty yards from the gun, and the second about the same distance farther on. These are connected by a fine insulated wire with the instrument, which is about 400 yards in the rear of the ordnance. The instrument is adjusted on a plan similar to an electro-ballistic machine. When the shot is fired, it cuts the wire in the first target, and then in like manner cuts the wire in the second target, the instant each wire is severed being recorded by the instrument. The interval of time occupied by the ball in passing from one target to the other furnishes the data for obtaining the initial velocity of the shot.

Noble's chronoscope is used for measuring the velocity of the shot during its passage through the gun. The ball presses upon a series of disks which in moving break or make electric connections, which are recorded on a rapidly rotating disk which has a known rate.

Chrys'o-type. (*Photography.*) A process by Sir John Herschel in which a sheet of paper is saturated with a solution of ammonio-citrate of iron dried in the dark. Exposed in a camera or printing-frame, the faint picture is developed by brushing over with a neutral solution of chloride of gold washed in water repeatedly, fixed by a weak solution of iodide of potassium, and then finally washed and dried.

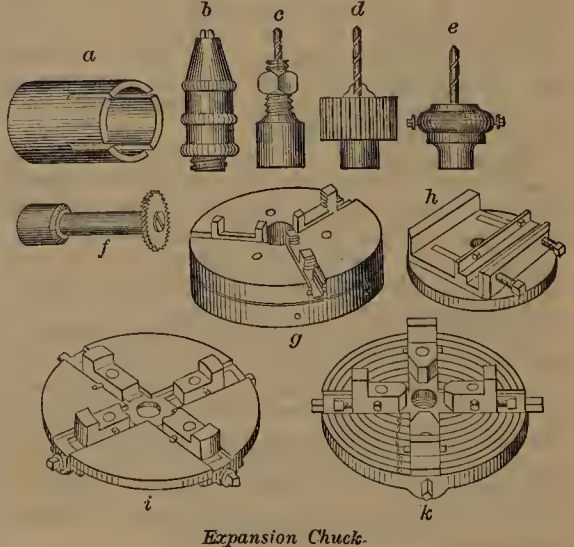
Chrys-tal'lo-type. (*Photography.*) A name given to a kind of picture on a translucent material. *Opalotype.*

Chuck. 1. An appendage to a lathe. Being screwed on to the nose of the mandrel, it is made to grasp the work to be turned. There are several varieties, as —

Arbor.	Geometric.
Branch.	Oblique.
Centering.	Oval.
Concentric.	Plain.
Driver.	Prong.
Eccentric.	Ring.
Elastic.	Screw.
Epicycloidal.	Surface.
Expanding.	Universal.

An *expansion* or *elastic* chuck *a*, having a certain range of capacity, may be formed by giving a quad-

Fig. 1287.



Expansion Chuck.

rafid cleft to the end of a cylindrical tube, whose other end screws on to the threaded mandrel of the lathe-head. The object to be turned is thrust into the chuck, expanding the quadripartite socket.

b is Beach's patent drill-chuck.

c, center-drill chuck.

d, Warwick chuck.

e, Morse's adjustable chuck.

A circular saw of small diameter may be mounted on a lathe-chuck *f*, which has an axial tenon to fit the hole in the saw, and a central screw or nut to fix the same.

Opticians use this mode for the small, thin saws with which they cut the notches in the tubes serving as springs in pocket-telescopes.

Carvers in ivory mount their saws in a similar manner. The saws for cutting the nicks in screw-heads, and those for making slits in gas-burners, may be chucked or mounted on a mandrel.

The small, wooden mechanism for the interior of pianos is cut by saws similarly mounted.

g is a scroll chuck with three radially adjustable dogs.

h is a planer chuck.

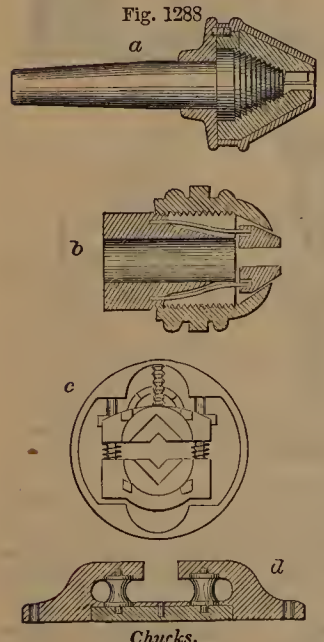
i is a screw chuck.

k is an independent jaw chuck.

The *eccentric chuck* is designed for changing the center of the work, and consists of two principal pieces; one attachable to the mandrel of the lathe and the other adjustable in a plane at right angles to the axis of motion, in a dovetail groove of the former piece. The sliding-piece is moved by a set screw.

The *elliptic* or *oval chuck* was invented by Abraham Sharp, and consists of three parts, the *chuck*, the *slider*, and the *eccentric* circle. The chuck is secured to and partakes of the circular motion of the mandrel. In front of the chuck is a dovetail groove for the reception of a slider, from the center of which projects a screw to which the work is attached. As the work turns round, it has a sliding motion across the center which generates an ellipse. The sliding motion is produced by an eccentric circle or ring of brass fastened to the puppet of the lathe close to the collar in which the neck of the mandrel runs.

Fig. 1288



Chucks.

A *straight-line chuck* is used in a *rose-engine* when the patterns are to be made to follow a straight instead of a circular direction.

A *geometric chuck* has a radial slider to which the work is attached, and this is so governed as to give a combined circular motion and radial oscillation to the work relatively to the tool. See GEOMETRIC-LATHE; ROSE-ENGINE.

Fig. 1288 shows three forms of lathe-chucks having jaws to grasp the tool or the work, as the case may be.

a. The stock of the chuck terminates in a conical, threaded head, which opens or closes the jaws, which are threaded, and slide in grooves in the conical shell.

b. The nut has a conical opening in the end which operates against the inclined backs of the jaws, to clamp them upon the drill; when relieved they are expanded by springs.

c. This chuck belongs to that class which is constructed with screws for the purpose of operating the jaws. It is provided with a double screw, the pitch of one being just half that of the other, to operate the jaws simultaneously in opposite directions so that they will approach or recede from the center at equal speed, thereby forming a self-centering mechanism.

2. (*Nautical.*) *d* is a *warping chuck* in which hawsers or ropes run. Friction rollers prevent the wearing of the rope. It is used on the rail or other portion of a ship's side.

Chuck-lathe. A lathe in which the work is held by a socket or grasping device attached to the revolving mandrel of the head-stock. It is used for turning short work such as cups, spools, balls, and a great variety of ornamental and useful articles. See CHUCK.

Churn. A vessel in which milk or cream is agitated to induce the separation of the oily globules from the other portions.

The ancient mode of making butter was probably the same as practiced by the Bedouin Arabs and the Moors in Barbary at the present day. The cream is placed in a goat-skin and agitated by hand or by treading it with the feet.

The butter and honey mentioned by Isaiah vii. 15, is to this day an article of food in the East. The butter and honey are mixed and the bread dipped in it.

The word *chamea*, rendered *butter* in our translation of the Bible, seems to have referred to several forms of milk and its productions, such as sweet or sour milk, cream, thick milk, curd, or butter. The latter is perhaps the most infrequent form of its use, but is evidently intended in those passages where the article is used for anointing. It was "butter of kine and milk of sheep" that made Jeshurun "wax fat and kick." Abraham "took butter and milk and the calf which he had dressed and set before" three stranger visitors. Sisera "asked water, and" Jael the wife of Heber the Kenite "gave him milk; she brought forth butter in a lordly dish" before she nailed him to the ground with a tent-pin and a hammer. Job refers to the time when he anointed his feet, or as he expressed it, "washed my steps with butter, and the rock poured me out rivers of oil." "Surely the churning of milk bringeth forth butter." The reader can pick out the various probabilities of each case for himself. It must be mentioned, however, that the word rendered *churning* may be just as correctly rendered *pressing*, and may refer to the pressing of curd to rid it of the whey. Sweet milk occupied but a limited space in the Oriental economy, ancient or modern. It necessarily became soon soured, and they accepted the situation. The *leban* (coagulated milk) of the Arabs was and is the usual form in which milk is used.

The Turks yet show their Tartar origin in the preference for sour over sweet milk.

We have a mention of butter in the description of the Scythians by Herodotus (*b.* 484 B. C.). "These people," says he, "pour the milk of their mares into wooden vessels, cause it to be violently stirred or shaken by their blind slaves, and separate the part that arises to the surface, as they consider it more valuable and more delicious than that which is collected below it." This is evidently *butter*.

Hippocrates (460 B. C.) describes the process

more clearly, stating that the lighter portion (butter) rises to the top, and the other part was separated into a liquid and solid portion (*curd* and *whey*), of which the former was pressed and dried (*cheese*).

Ths butter is recommended by this "father of medicine" as an ointment, and subsequently by Galen, A. D. 131.

The poet Anaxandrides, describing the wedding of Iphicrates, who married the daughter of Cotys, king of Thrace, wondered that the latter people *ate* butter.

The references to butter are occasional only; by Aristotle, who speaks of it as the oily part of milk; by Strabo, who speaks of its use by the Ethiopians; by Plutarch, who speaks of a Spartan lady anointed with butter, and smelling so loudly that Berenice, her hostess, positively could not stand it. Berenice on her part smelt so strongly of rancid oil, that the Spartan was happy to leave.

Dioscorides and Galen refer to the use of butter as a substitute for olive-oil as a dressing for table use or for leather. Lamp-black, obtained by the burning of butter, they recommend for an eye-salve.

Pliny describes the use of butter and cheese by the "barbarous" Germans. The Romans used butter for anointing, the Germans for a hair-dressing, the Egyptians for burning. None of them probably knew the taste of good, hard, clean butter.

The Christians of Egypt used butter instead of oil in their lamps in the third century. It was easier to raise cattle than olives, apparently, in that land where it is said it now costs less than three dollars to raise a child to maturity.

The Arabians and Turks have a preparation of curdled milk, called *leban* by the former and *yaourt* by the latter, which they preserve in bags. In appearance it resembles pressed curds after they have been broken by the hand; mixed with water it becomes a cooling drink, and is said to be wholesome and serviceable in febrile diseases. It probably formed the last meal of Sisera.

Fresh *yaourt* is much used as food by the natives, and Europeans soon acquire a taste for it.

The butter received at Constantinople from the Crimea and Kuban is not salted. It is prepared by melting in large pans and skimming off the impurities which rise to the surface. Butter thus prepared is called *ghee* in India. It is used for food by some castes and for anointing. Ghee is used to soak the wood on which the victim of the *suttee* is sacrificed.

The classes and varieties of churns are so numerous that justice cannot be done to the subject within admissible bounds. The following classification, with an example of each, will afford a glance at the distinctive kinds.

1. The *plunger* churn. *a* represents the vertical-dasher plunger churn. A spring assists in the recoil or lifting motion. Rotation of the dasher may be given by a spiral on the stem, or by giving a spiral set to the blades.

b is a horizontally operated dasher churn.

2. *Barrel* churn. *c* has a pair of dashers revolving in different directions by distinct cranks. In a modified form, the barrel is mounted on trunnions and is itself rotated.

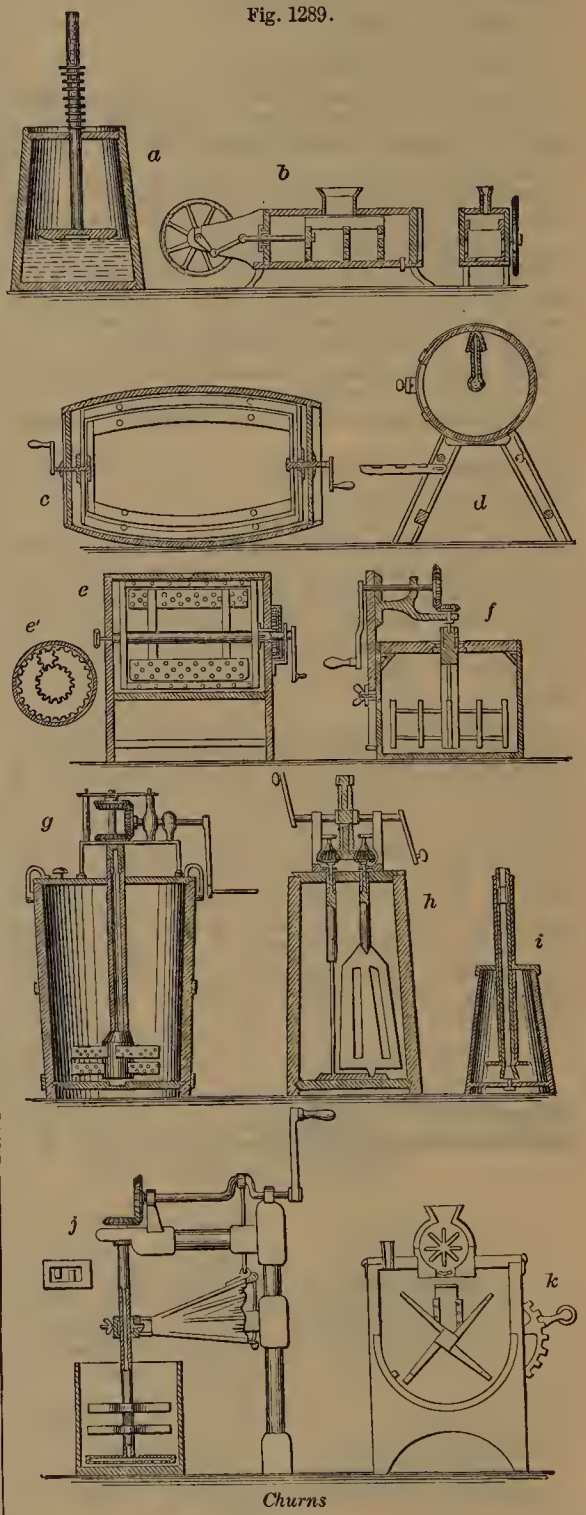
d has a stationary barrel and one rotated dasher.

3. *Box* churn. *e* has two dashers revolving at different speeds. The inner dasher is driven by the crank-axis direct; the outer one by an internally geared wheel, a pinion, and a third wheel on the sleeve which carries the dasher. The arrangement of wheels is shown at *e'*.

4. *Tub* churn. *f* has a vertical dasher-shaft rotated by wheel and pinion from the crank-shaft.

g has two dashers rotating in different directions, one driven by the central axis and the other by the

Fig. 1289.



Churns

sleeve axis. Each axis has its own pinion, driven by a common wheel.

h has a pair of parallel dashers driven in contrary directions by the master-wheel, which acts upon the respective pinions.

5. *Atmospheric* churn. *i;* as the dasher rises, the valve on the upper end of its stem falls and admits air, the valve on the hollow guide-rod closing. As

the dasher descends, the action of the valve is reversed, and the air issues into the milk at the openings in the lower end of the hollow stem.

j has a bellows arrangement supplementary to the beating action of the dashers.

There are many other varieties of atmospheric churns; some have cup-shaped dashers, to carry air down into the milk; others operate by centrifugal action.

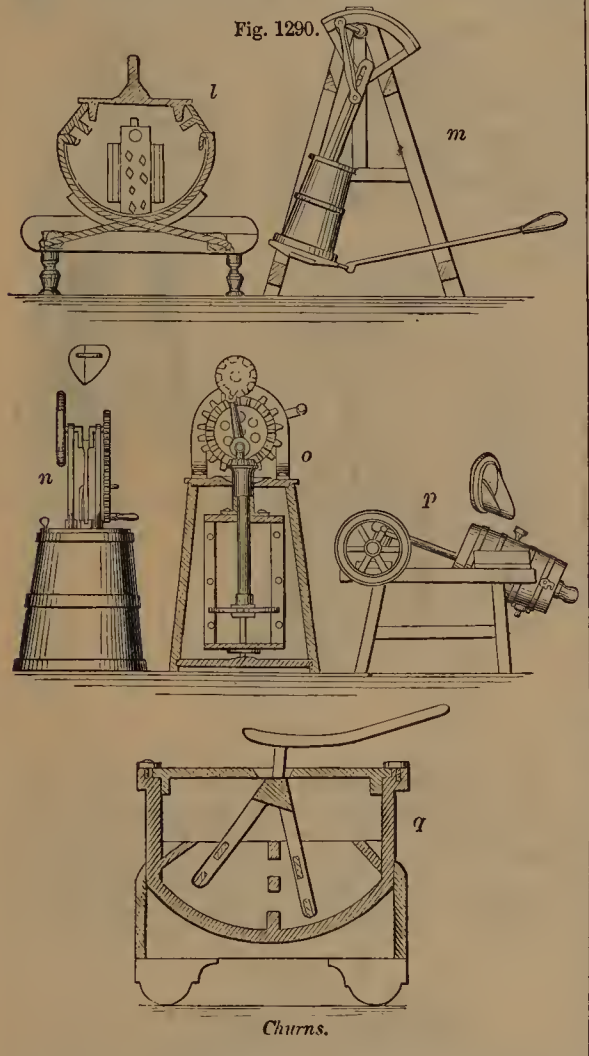
6. *Compressor* churns. *k* has a rubbing or grinding action on the cream in the upper chamber, the intention being to break the little sacs which contain the butyric particles.

7. The *Rocker* churn, *l*, Fig. 1290.

8. The *Pendulum* churn, *m*.

The churn rests in the swinging frame, the uprights of which are slotted for traverse of the axial

Fig. 1290.



Churns.

pin, and have segmental bars bearing upon the dasher crank-shaft, and causing its reciprocating rotation.

9. The *Divided* dasher churn, *n*, has a pair of dashers vertically reciprocating and operated by the respective cranks on the common shaft.

10. The *Revolving* and *Reciprocating* churn, *o*; the shaft carries a rotary dasher whose wings act as slides for the arms of a reciprocating dasher. An inner sleeve carries the reciprocating dasher and passes through an outer sleeve carrying the pinion of the rotary arm.

11. The *Oscillating* churn, *p*; the cylinder is suspended on trunnions and oscillated by the reciprocating dasher-shaft, which is connected to the revolving crank.

12. The *Oscillating* dasher churn, represented at *q*.

13. The *Thermometric* churn, in which the box or the dasher-shaft has a thermometer to give constant indication of the temperature of the cream.

Numerous patents have been granted for matters of detail such as: —

Water-tanks for hot or cold water to temper the cream. Ivory bushings to prevent the taint of brass, or the rust of iron. Materials, such as glass, stoneware, etc.

An artificial butter is made from suet, which is first finely divided by circular saws in a cylinder; then treated with water, carbonate of potassa, and finely divided fresh sheep's stomachs at a temperature of 45° C. The pepsin and heat separate the fat, which floats on the surface, whence it is decanted, and when cool, placed on an hydraulic press, which separates the stearine from the semi-fluid oleomargarine, which is employed as follows. in the preparation of the butter: 50 kilogrammes of the fat, 25 liters of milk, and 20 liters of water are placed in a churn; to this, 100 grammes of the soluble matter obtained from cows' udders and milk-glands is added, together with a little annotto. The mixture is then churned, when the butter separates in the usual manner.

In connection with this subject, we may be pardoned introducing a short account of how royalty churns by proxy and how nice a dairy may be made when "expense is no object."

Prince Albert's model farm is about a mile from Windsor Castle. The dairy is a beautiful cottage with a marble-paved and frescoed vestibule. The interior is a room about thirty feet square, the roof supported by six octagonal columns of white marble, with richly carved capitals. The floors are of white porcelain tiles, the windows stained glass, bordered with hawthorn blossoms, daisies, buttercups, and primroses. The floors are lined with tiles of porcelain of a delicate blue tint, with rich medallions inserted of the Queen, Prince Consort, and each of the children. Shields, monograms of the royal family, and bas-reliefs of agricultural design, representing the seasons, complete the ornamentation of this exquisite model dairy. All around the walls runs a marble table, and through the center two long ones, supported by marble posts, resting on basins through which runs a perpetual stream of spring water. By this means the slabs of table are always cold, and the temperature of the dairy is chill, while the white and gilt china milk and butter dishes resting on the tables are never placed in water. The delicious milk is brought in in bright metal buckets, lined with porcelain, the Queen's monogram and crest glittering on the brass plates on the covers. In the room where the butter is made, milk skimmed and strained, the eyes may be feasted on the rows of metallic porcelain-lined cans of every size, made to lock, and sent to the royal family even as far as Scotland; so they always have good milk and butter. The churn was of metal also, and lined with porcelain, made in two compartments. The outside chamber surrounding the cylinder can have warm or cold water poured in to regulate the temperature. The lid is screwed on, and the stationary stand on which the whole is turned makes the work easy and rapid. But while over sixty cows are daily milked, and as many more are out grazing, the royal family are more than satisfied, and the Londoners growl that the overplus is sold and the money pocketed by their money-saving sovereign.

2. (*Porcelain.*) The block or chuck on a porcelain turner's lathe, on which the thrown and baked articles are turned by thin iron tools to give truth and smoothness to circular articles.

Churn-dash'er. The moving agent in a churn, rotary or reciprocating, by which the milk or cream is agitated.

Churn-drill. A large drill used by miners. It is several feet long, and has a chisel-point at each end.

Churn-pow'er. A motor for driving churns or churn-dashers to agitate the milk or cream.

Animals, such as dogs, sheep, or goats, are employed in treadmills or slatted platfroms on endless belts.

The power of descending weights, springs, wind or water driven wheels, etc., are used.

Chute. An inclined trough.

On a moderate scale it forms a leader, or feeder for materials or blanks, to machines.

On a large scale it leads water from a penstock to a water-wheel, or an inclined plane down which logs are passed from a higher level to a lower one. These are sometimes in mountainous countries for land transportation, and sometimes are the links of a slack-water system, as on the Ottawa ; called *slides.*

Ci-bo'ri-um. (*Architecture.*) An insulated arched vault resting on four pillars, as that over the high altar of a church.

Ci'der-mill. A grinder for apples generally, in practice, including the press in which the pomace is pressed.

The common cider-mill *a*, used in the Southwest of England, is on the principle of the Chilian mill, being a cylindrical stone weighing one or two tons, and rotating in an annular trough of masonry.

The axis of the stone is connected by arms to a sweep which is pivoted on a central post and revolved by a horse. In some cases the central space forms compartments for holding apples. The roller is from 2½ to 4½ feet in diameter, and 9 or 10 inches wide at the face. The trough is somewhat wider at top by the inclination of its outer side, to allow freedom of motion to the runner. The bed is from 9 to 12 feet in diameter.

Cider-mills in England are also made with hollow iron fluted rollers, working in pairs and meshing into each other.

In Ireland the apple is crushed between wooden cylinders studded with iron teeth ; the pomace is afterwards pounded with wooden pestles.

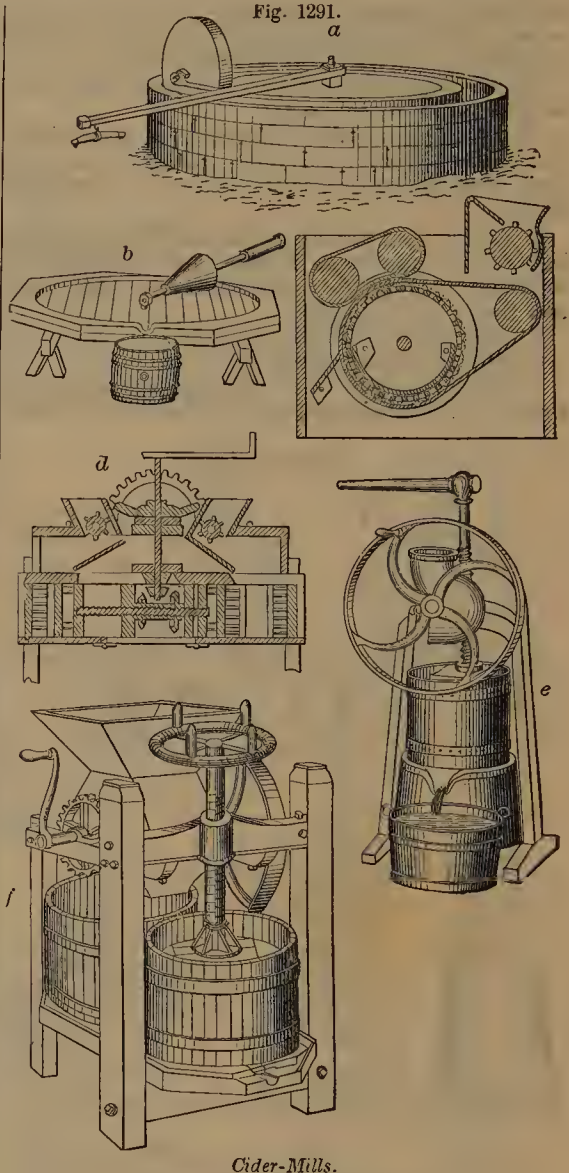
The *cider-press* of the West of England is a modification of the common screw-press. The pomace is enclosed in a bag of haircloth about 4 feet square, and holding two or three bushels. These are heaped over each other in the press, to the extent of fifteen or eighteen bags. These yield from 100 to 200 gallons of juice, according to number and the succulency of the apples. The press-screw is manipulated by a lever.

The *cider-mill* (*b*) used in the South of France has a platform of boards framed together and is traversed by a conical frustum of cast-iron whose axis is hooked to a rotating eye in the center of the platform and is swept around by manual power, crushing the fruit in its passage.

The mill *c* has a grinding-wheel and concave, and an apron which carries the pomace between two pressing rollers and a wire-screen cylinder through which the juice runs.

d has alternate grinding portions and a double-headed piston, which presses the pomace against the ends of the box alternately. One end of the box is filling while the other is pressing.

Fig. 1291.



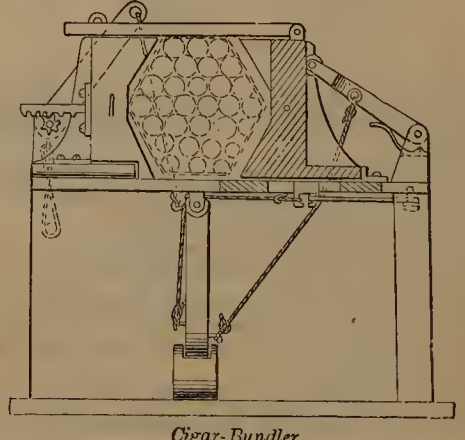
Cider-Mills.

e has a metallic grinder and a hoop with a screw.

f has a grinder and presser, which may be acting simultaneously. A hoop filled with grindings is pushed from below the hopper to beneath the screw, and an empty hoop substituted beneath the former.

Ci-gar'. A roll of tobacco-leaves for smoking. It

Fig 1292.



Cigar-Bundler.

has a pointed mouth-end and a square-butted lighting-end. The word is derived from Spanish *cigarro*, a kind of tobacco grown in Cuba. Also spelt *segar*. The *cheroot* is the cigar of the Manillas, and has a regular taper, but both ends are squarely cut off, one of course is smaller than the other.

Ci-gar'-bun'dler. A clamping-press having jaws of such shape and capacity as the size of the cigar and the number desired in a bundle may warrant. The required number being placed between the jaws, the latter are drawn together by the pressure of the foot on the stirrup and cord, and the jaws locked by an arm while the tie or band is placed around the cigars.

Ci'gar-ette'. A small package of cut tobacco done up in a rolled paper envelope. The envelope is made of rice, tobacco, or corn-husk. The latter is the best.

Ci'gar-ette'-fill'er. A little implement for introducing the finely cut tobacco into the paper envelope. It has two forms; a tube and a wrapper. The former is shown in Fig. 1293. A roll of paper is wrapped around a tube, and its inner end clamped between two short tubes or collars; the tube is filled with tobacco and withdrawn, leaving the tobacco in the paper envelope. A hollow piston maintains the position of the tobacco while the tube is withdrawn and forms a stem.

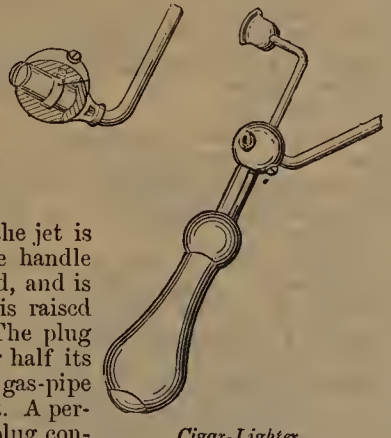
Fig. 1293.

Cigarette-Filler.

Ci gar-ette'-ma-chine'. Adorno's cigarette-machine uses an endless roll of paper. It cuts, wraps, and folds the paper around a regulated quantity of tobacco, which is supplied at one end of the machine, while the finished cigarettes emerge at the other end.

Ci-gar'-light'er. A little gas-jet suspended by an elastic tube. It receives gas through its trunnions; the jet is decreased as the handle hangs suspended, and is increased as it is raised for lighting. The plug is chambered for half its length, and the gas-pipe is screwed into it. A perforation in the plug connects the interior with a channel on its periphery and in the socket, the channel being regulated by a screw.

Fig. 1294.



Cigar-Lighter.

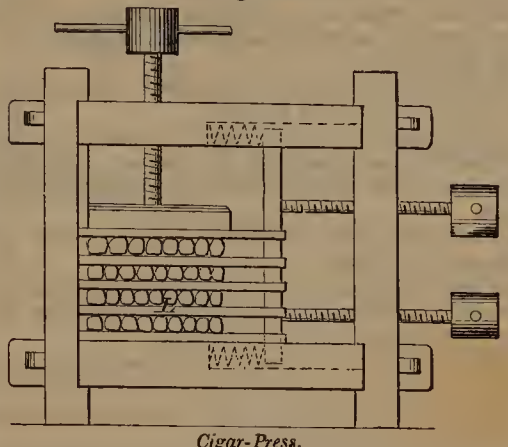
Ci-gar'-ma-chine'. For making fillers of cigars and wrapping them. The operations are generally conducted in a series of machines: one cuts wads of cigar length and quantity from a stream of cigar-leaves packed and traversing in a chute whose width is equal to the length of a cigar; the wad thus cut off is driven into a mold which gives it the cigar-shape, and in this it is left to dry, so that when removed it only requires the wrapper to complete it. This is put on in another machine in which the filler is laid bias upon the strip of leaf, and rolled thereon, a pad or apron simulating the action of the human palm. The tip is finished separately, and then the stub-end cut off squarely.

Another mode of procedure is to lay a suitable bunch of leaves in an apron which is lapped around them so as to form them into a sufficiently tight roll; or the rolling device consists of a set of cylinders in a circular series, which opens to admit the bunch of leaves, and when closed forms a cylindrical space in which the bunch of leaves is rolled and pressed into a shape for the molds in which it is eventually pressed to the required shape for a filler. The latter is covered by hand or by a machine.

Ci-gar'-press. A press having a motion in two directions: one to compress the cigars in their rows, and the other to press them vertically.

The press has side-screws working horizontally, and a vertical screw so placed as to be over the stack containing the cigars; the side press-board slides in the slotted sides of the horizontal boards. The cigars are arranged upon the boards with intervening slats.

Fig 1295.



Cigar-Press.

Ci-gar-steam'er. A peculiar form of craft, shaped like a spindle, and constructed by Winans, of Baltimore.

The first was built in Baltimore — length, 635 feet; diameter, 16 feet.

Second, in St. Petersburg — length, 70 feet; diameter, 9 feet.

Third, in Havre — length, 72 feet; diameter, 9 feet.

Fourth, in Isle of Dogs — length 256 feet; diameter, 16 feet.

The propeller of the first was placed around the middle of the vessel; the second had a propeller beneath her bottom; the third is fitted for trying propellers in various positions; and the fourth has a propeller at each end.

Cim'e-ter; Scim'e-ter. An Oriental cavalry sword with a blade of great curvature.

Cinc'ture. (*Architecture.*) A fillet or ring dividing the capital from the shaft. Another cincture divides the latter from the base.

Cin'der. 1. A scale of oxide removed in forging.

2. Certain kinds of light slag in metallurgic operations.

Cin'der-frame. (*Steam-engine.*) A wire-work frame in front of the tubes of a locomotive, to arrest the passage of large pieces of ignited fuel.

Cin'que-foil. (*Architecture.*) A five-leaved ornament used in the arches of the lights and tracery of windows, panelings, etc.

Ci-on'o-tome. An instrument for excising a portion of the uvula.

Ci'per-tun'nel. A false chimney placed on a house for ornament or uniformity.

Cip'pus. A low column, sometimes round, but more frequently rectangular, used as a sepulchral monument.

Cir-cas'si-enne. (*Fabric.*) A light kind of cashmere.

Cir'ci-nus. The compass of the Romans, described by Vitruvius.

Cir'cle. 1. This plane figure — comprehended by one line, every part of which is equally distant from the same point — gives a name to a number of instruments, among which are the following (which see) : —

Mural circle.	Circumferentor.
Reflecting circle.	Circular saw.
Repeating circle.	Circular shears, etc., etc.

2. The fifth wheel of a carriage.

Cir'cle-i'ron. 1. A hollow punch for cutting planchets, wads, wafers, and circular blanks.

2. A *fifth wheel.*

Cir'cuit. A continuous electrical communication between the poles of a battery.

(*Telegraphy.*) The wires and instruments forming the road for the passage of the current. At its extremities are the terminals, where it joins the instrument.

A *metallic* circuit is when a *return wire* is used instead of the earth.

A *short* circuit is one having as little resistance as possible ; nothing but the apparatus and the wire used to connect it with the battery.

To *short circuit a battery* is to connect its poles by a wire.

A *local* circuit includes only the apparatus in the office, and is closed by a *relay.*

Cir'cuit-break'er. (*Telegraphy.*) An instrument which periodically interrupts an electric current. The name *Rheotome* was given to it by Wheatstone.

With the automatic apparatus, the circuit is closed through the armature to and through the electro-magnet by which it is controlled. When thus closed to the magnet, the latter attracts the armature, breaking the circuit. The armature is then retracted, so that the circuit is again completed, and so on.

The simplest and first form of rheotome or circuit-breaker was a file connected to one wire of a battery, the other wire being rapidly drawn over the surface of the file alternately in contact with a tooth and hopping to the next one.

Another form is a spur-wheel moved by hand or clock-work ; this is common in telegraph instruments and in electro-magnetic machines.

Cir'cuit-clos'er. (*Telegraphy.*) Primarily any device by which an electrical circuit is closed. Usually a key ; as the common telegraph key.

In fire alarms and many automatic telegraphs, it is a plain metallic disk with insulated spaces on the rim or edge. A flat spring pressing upon the edge closes the circuit when upon the metallic portion, interrupts it when on the insulated portion. See DIAL.

In place of metallic and insulated spaces, projections or cogs are sometimes used, the interdental spaces answering the purpose of insulated spaces.

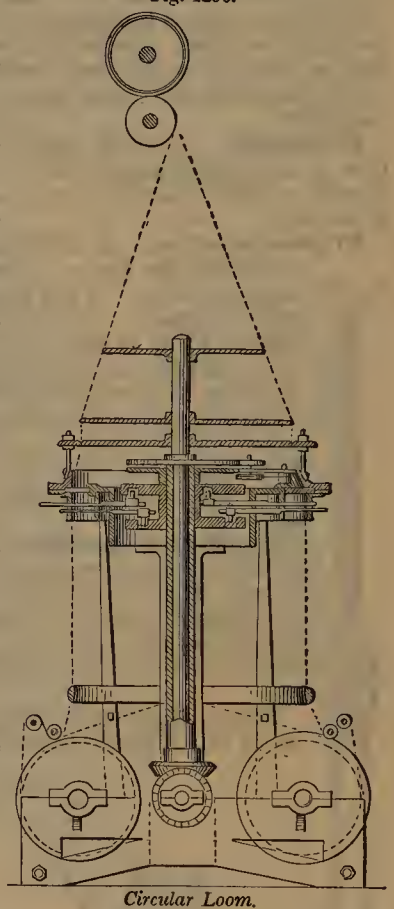
Cir'cu-lar Bolt. A machine employed by the Nottingham, England, lace manufacturers in making net.

Cir'cu-lar File. A circular saw or serrated disk, adapted to run on a spindle or mandrel, and used in cutting teeth of cog-wheels.

Cir'cu-lar In'stru-ments. Astronomical, nautical, or surveying instruments which are graduated to 360°, that is, around the whole circle. Of this kind are *altitude, azimuth, mural, reflecting,* and *repeating circles ; circumferentors* (which see).

Cir'cu-lar Loom. A loom in which the shuttle moves in a circular race and continuously in one direction through warps arranged in a circle. The cut shows a loom of this class ; the warps proceed from beams or creels near the floor, pass through a ring which brings them in a circle, then through eyes in horizontally reciprocating slides which form the shed, then through between the dents of the circular reed to the take-up mechanism. The shedding-slides are moved by cams on the main vertical shaft. The shuttle is sustained by and moves on the dents of the reed, and is driven by means of an arm provided with a roller which presses against the head of the shuttle and allows the passage of the warp between them. The shuttle may be provided with a projection to beat up the filling, or comb-like arms made in sections may be made to beat the filling between the warps.

Fig. 1296.

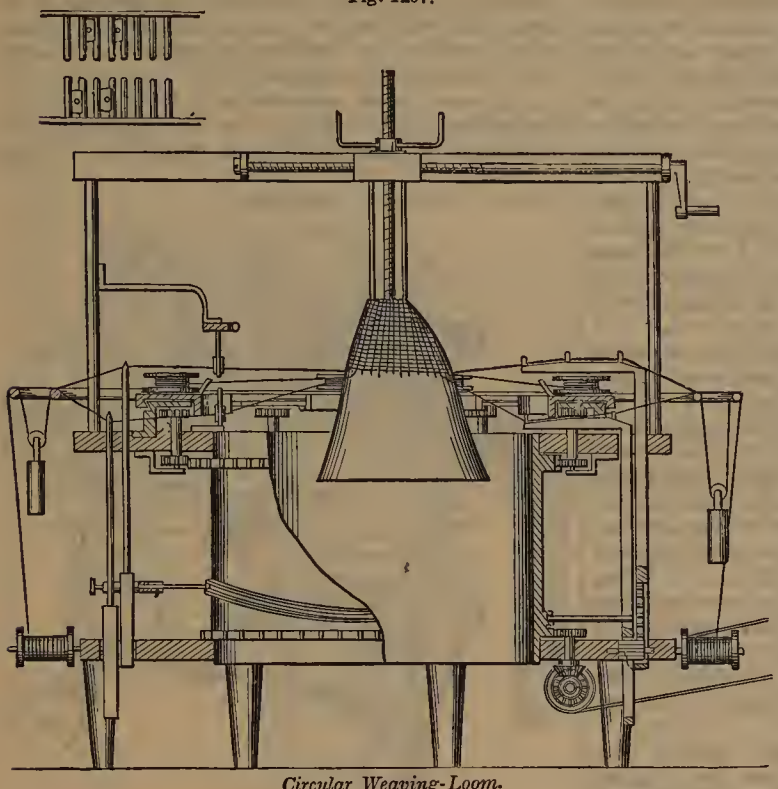


Circular Loom.

Another form is one in which the material is woven around a former which gives it size and proportion, as in Fig. 1297, which is a machine for weaving petticoats and hoop-skirts. The fabric is woven around a block suspended between the warp-carriers and the track of the shuttles, said block being movable vertically and laterally, in order that it may be adjusted centrally. The shuttles move on a circular or other endless track, and deposit their woof threads alternately above and below a warp thread around the block. The warp-carriers receive an alternate vertical reciprocating motion from a cam on a revolving drum, from which the shuttles also derive their motion.

The warp-threads have to be spread, so as to have them equidistant from each other around the block. For that purpose the carriers have horizontal extensions, which are diverging, like spread fingers, so that the desired effect is produced, and the desired distance between the warp-threads obtained, without requiring the spreading of the carriers, which are arranged in groups of six, more or less. To diminish friction in the operation of the carriers,

Fig. 1297.



Circular Weaving-Loom.

such grouping is necessary, as otherwise each carrier would require its own connection with the cam on the drum.

The cam only operates one set of each group of carriers, and the carriers, which are thus alternately raised and lowered, impart, by means of gearing or otherwise, motion to the other set of carriers, so that the same always moves in the opposite direction with the first-named set.

Cir'cu-lar Mi-crom'e-ter. The *circular* or *annular micrometer* was first suggested by Boscovich in 1740, and was afterwards revived by Olbers in 1798. The principle is as follows: —

"If the field of a telescope be perfectly circular, and its diameter be determined by observation, the paths of two celestial bodies across the field may be considered as two parallel chords which are given in terms of a circle of known diameter. The differences of the times at which two stars arrive at the middle of their paths will be their ascensional differences; and the distance between the chords, which is readily computed from their lengths, gives the difference of the declination of the two bodies." — BRANDE.

The annular form devised by Fraunhofer is the more convenient instrument, as it permits the moment of ingress and egress to be determined more readily. It consists of an annular glass disk with a steel ring cemented on the inside to form the circular aperture as before described.

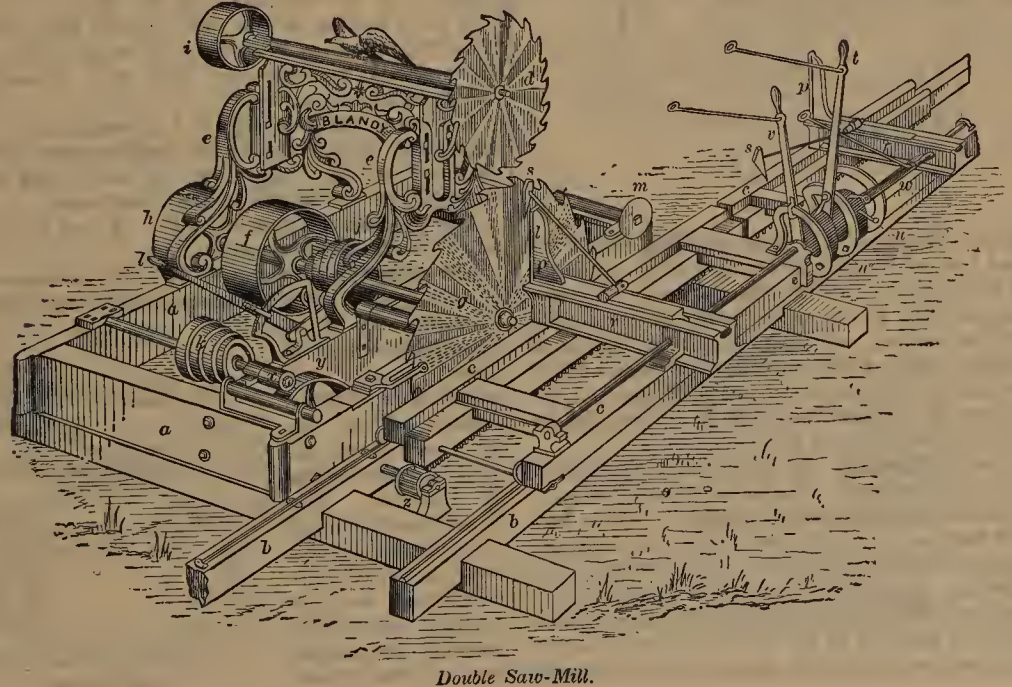
Cir'cu-lar Saw. The circular saw was introduced into England about 1790, but its inventor is not known.

General Bentham contrived the bench, slit, parallel guide, and sliding bevel guide. He also invented making circular saws of segmental plates.

One was patented in England by Trotter, 1804. Brunel's veneer-saw, 1805 – 1808.

The double saw-mill shown in the illustration is of the Blandy pattern, selected from a multitude of others as a good specimen of its kind. *a* is the frame of the saw-mill proper, *b* the ways on which the log-carriage *c* traverses. *g* is the lower saw, which may have an average diameter of, say, 60 inches.

Fig 1298.



Double Saw-Mill.

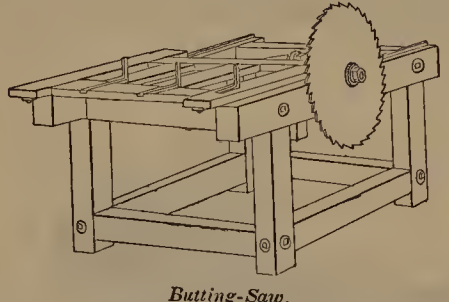
and a rate of revolution of, say, 500 to 600 revolutions per minute, varying with the kind of wood and the diameter of the saw. *d* is the upper saw, whose arbor has its bearings in the iron frame *e e*, which may be detached, with all its appendages, from the sill pieces *a a*, so that the machine then becomes a single saw-mill, the working radius of the saw being sufficient for the run of logs of the locality. *f* is the band-pulley of the lower saw, and *h i* are the pulleys by which the motion of the lower saw-arbor is communicated to the upper saw *d*. *j k* are the cone-pulleys concerned in the *feed* and *gig-back* motions of the log-carriage *c*. *l* is the lever by which the direction of motion of the carriage is regulated.

p p are the knees of the head-blocks *r r*, on which the log lies and is fastened by the dogs *s s*. These head-blocks are adjustable longitudinally on the carriage, according to the length of the log, and the knees of the head-block are set up closer to the saw after each cut of the saw, to a distance equal to the thickness of board required and the width of the kerf. The setting up of the knees is done simultaneously by the vibration of the lever *t*, which has a pawl acting upon each of the ratchets *u u'*. When it is desired to saw a board thicker at one end than at the other, the knees on the respective head-blocks are moved independently by the levers *v w* respectively, these levers having each a pawl to actuate that one of the ratchets *u* which belongs to the appropriate head-block.

The feed-motion of the carriage *c* consists of a friction-wheel *x* on the pulley *y*; on the arbor of the latter is a pinion *z*, which meshes with the rack on the under side of the log-carriage. The direction of rotation of the pinion *z* determines the feed or gig-back motion, which is controlled by the position of the lever *l* on the quadrant. *m* is a revolving wedge which enters the kerf and spreads the board from the log.

One form of circular saw for cross-cutting cord-wood, or butting framing-timber, is shown in the annexed cut. The wood lies upon a sliding-frame and is pushed toward the saw and drawn back by hand.

Fig. 1299.



Butting-Saw.

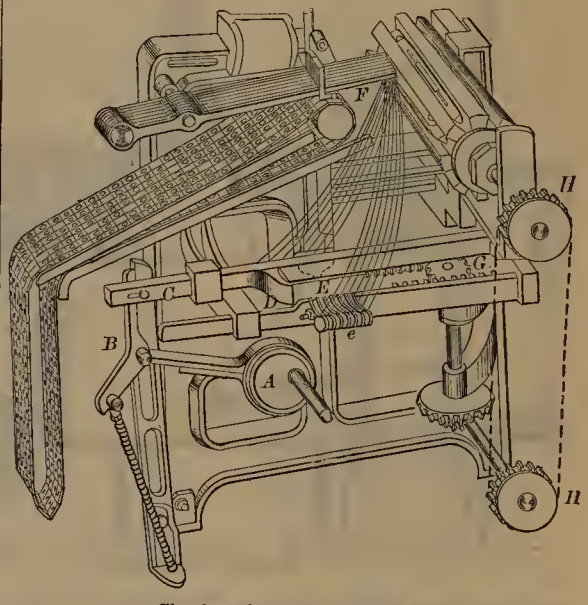
Saws are made in Trenton, New Jersey, 88 inches in diameter, with 48 insertable teeth, and, allowing 6 inches for collars, are adapted to cut boards 41 inches wide. Such a saw is designed to make 375 to 400 revolutions per minute, to cut 6 inches to a revolution, and is declared capable of cutting 50,000 feet of inch lumber in ten hours.

Cir'cu-lar Shears. A shears for sheet-metal consisting of two circular blades on parallel pins.

Cir'cu-lar Shut'tle-box Loom. A loom having a box with a number of shuttles, six in the figure, and having means for actuating it so as to bring any one of the six shuttles into operation as required by the pattern. The circular shuttle-box is mounted on an axle at one end of the sley, and has a positive revolving motion given to it, when required to change a shuttle, by a chain *H* actuated by gearing *G* in connection with two racks, the amount of motion being regulated by tumblers connected to jacks or levers governed by Jacquard cards.

A is an eccentric connected to a lever *B*, for giving motion to the sliding bar *C*, furnished with projections *D*, which act upon tumblers *E* when

Fig. 1300.



Circular Shuttle-Box Loom.

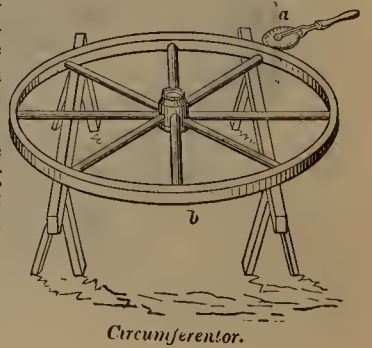
they are lifted by the cards connected to the jacks or levers *F*, which is whenever there is a blank in the part of the card opposite to the jack or lever. When these tumblers are lifted they fall into slots in the racks, and being caught by the projections *D*, the racks are carried forward and the pinion *G* turned; this gives motion to the upright shaft and bevel wheels, through them to the chain wheels *H H*, one of which is on the axle of the shuttle-box. Each jack or lever *F*, except the two end ones, is connected to two tumblers, one on each rack; and as the racks are on opposite sides of the pinion, the tumbler gives motion to the rack on one side, and the other tumbler acts as a stop, and regulates the exact distance that the opposite rack, and consequently the shuttle-box, moves.

Cir'cu-lat-ing-pump. (*Steam-engine.*) The cold-water pump by which condensation water is drawn from the sea, river, or well, and driven through the casing of a surface condenser.

Cir'cu-lus. (*Glass-making.*) A tool for cutting off the necks of glass-ware.

Cir-cum'fer-en'tor. 1. A *tire measurer*. A wheel, *a*, graduated on its periphery and axled in a holder. It has a circumference of known length, and is passed around the outside of the rim of a wheel, *b*, to ascertain the length of the tire. The instrument having a perimeter, say 2 feet in circumference, the zero is brought to a marked spot on the periphery of the wheel

Fig. 1301.



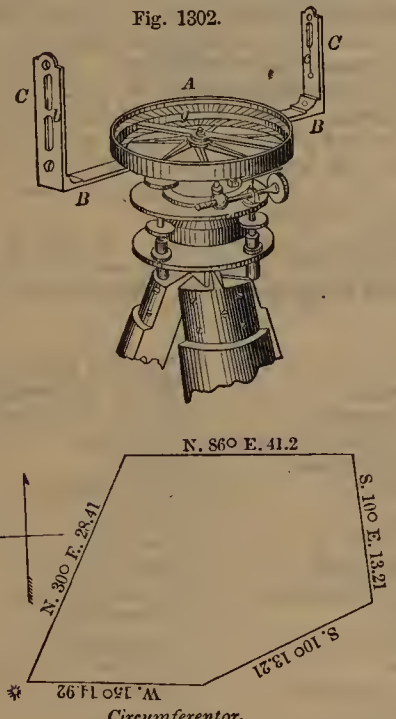
Circumferentor.

to be measured. The small wheel is then caused to travel around the larger, and indicates the length by making so many revolutions and such a fraction, as the case may be. A *tire-circle.*

2. A surveying instrument; used commonly in mines, coal-pits, etc., in England, but a very common instrument in the United States for surveying. Many of the old-fashioned surveyors yet use it, though it is disappearing as the theodolite becomes more and more commonly known.

It consists of a flat bar of brass *B B* about 15 inches in length, with sights *C C* at its opposite ends, and two narrow slits *b c* for observations; in the middle of the bar is a circular brass box *A*, containing a magnetic needle and covered with glass. The ends of the needle play over a brass circle *g*, which is divided into 360°, in such a manner that the two numbers of 90° are at right angles to the lines drawn through the sights. The

Fig. 1302.



Circumferentor.

instrument is supported by a ball and socket-joint on a staff or tripod. When the magnetic needle is well balanced and moves freely in its horizontal position, the sights can be turned towards the object to be surveyed, and the needle will retain its position of N. and S. The number of degrees which the angle contains after moving from one object to another can be counted off on the graduated circle. The lower part of the figure shows the mode of reading and plotting the bearings.

Cir'cum-flex. The mark ["^"] over a vowel, indicating a certain accent.

Cir'cum-val-la'tion. (*Fortification.*) An encircling line of field-works.

Cir'cum-vent'or. A surveying instrument having a compass-box at top for taking angles. See CIRCUMFERENTOR.

Cis'so-tome. (*Surgical.*) An instrument used in the extirpation of a varix; that is, a varicose or dilated vein.

Cis'tern. 1. A tank or other form of artificial reservoir for containing a supply of water.

Cisterns have always been very common in lands subject to occasional abundant supply with intervals of drouth. In India cisterns are on a very large scale; in Egypt they assumed the proportions of lakes; in Ceylon are the remains of many on a scale far beyond the ability of the Cingalese population either to construct or utilize.

The change of domicile of the Israelites from a land of annual overflow to a land of rains, from a land of artificial irrigation to one of running waters, was cited as one of the peculiar advantages in their removal from Egypt to Palestine. "For the land whither thou goest in to possess it is not as the land of Egypt from whence ye came out, where thou sowedst thy seed, and wateredst it with thy foot, as a garden of herbs; but the land whither ye go to possess it is a land of hills and valleys, and drinketh water of the rain of heaven." — Deut. xi. 10, 11.

Yet even in Palestine cisterns were a necessity, the rains falling only in spring and autumn. The pools of Solomon are near Bethlehem, and are 3 in number, on the slope of a hill, and one above another, so as to form a chain of pools. The breadth of each is from 80 to 90 paces; the upper pool is about 160 paces, the second 200, the third 220. The water was conducted to Jerusalem.

The Romans built magnificent and elaborate cisterns, many of them on such a scale that they are called reservoirs. They made them every 20,000 feet in their aqueducts, to act as reserve and admit of repairing the conduit. Near the baths of Titus in old Rome are nine subterranean cisterns 17½ feet wide, 12 feet high, and about 137 feet long.

The baths were constructed with a number of separate lavatories, named according to the temperature, the *frigidarium*, the *tepidarium*, the *caldarium*, or *balneum*. These were made of masonry or concrete.

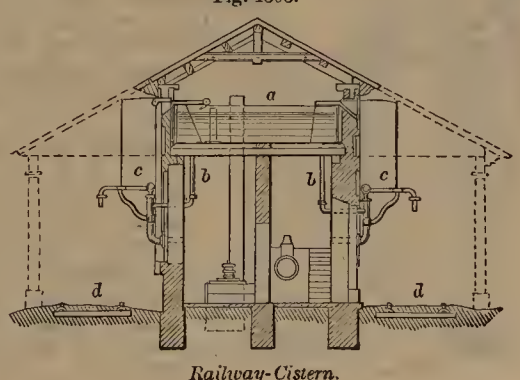
The material was broken stone and the best of mortar. The mortar was made of pure, clean sand, 5; lime, 2 parts. The stone was flint, of which no piece weighed over a pound.

Several divisions were made in the cisterns which were used for supply of water, which passed from one to another, depositing its impurities.

The reservoirs which received the water from the aqueducts, and from which the supply was distributed, had three pipes of equal diameter, so connected that when the water overflowed at the extremities it was discharged into the middle one, which supplied the pipes for the fountains; a second pipe supplied the baths; a third one the private houses. The public supply was never deficient nor could it be diverted. A tax was levied on the private houses, which was expended in keeping the aqueduct in repair.

In Fig. 1288, *a* is the elevated cistern used for supplying locomotive-tenders. The jointed pipes

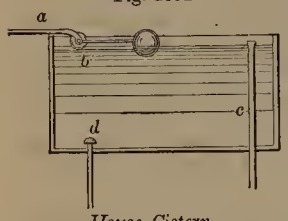
Fig. 1303.



Railway-Cistern.

c c are maintained in elevated position by counterbalance weights when water is not being discharged. On pulling them down, as shown in the figure, by means of an attached cord, a valve at the joint allows water to flow through them from the pipes *b b*, and into the reservoir of a tender standing on either of the tracks *d d*. This is also known as a *water-crane*.

Fig. 1304.



House-Cistern.

Fig. 1304 is the cistern used in houses when the water supply is intermittent; it has a *main-service* pipe provided with a *ball-valve*, a *house-service* pipe *a*, provided with a ball-cock *b*, and a rose to strain the water, a *standing waste*-pipe *c*, to allow excess of water to run off, and a *waste*-pipe *d*, which allows the cistern to be emptied for cleansing, when the *standing*-pipe is removed.

Capacity of Cisterns in Gallons for each Ten Inches in Depth.

Diam. in Feet.	Gallons.	Diam. in Feet.	Gallons.
2	19.5	8.5	353.72
2.5	30.6	9	396.56
3	44.6	9.5	461.4
3.5	59.97	10	489.6
4	78.33	11	592.4
4.5	99.14	12	705
5	122.4	13	827.4
5.5	148.1	14	959.6
6	176.25	15	1,101.6
6.5	206.85	20	1,958.4
7	239.88	25	3,059.9
7.5	275.4	30	4,406.4
8	313.33		

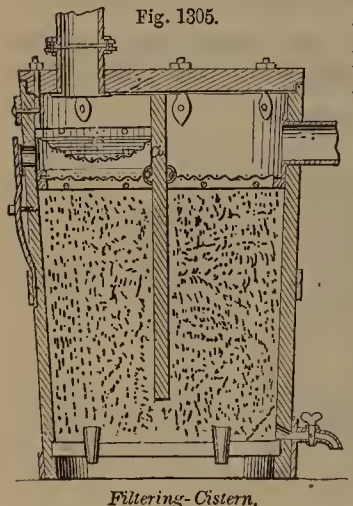
2. (*Mining.*) A tank in a deep mine shaft, set upon a *scarcement;* it serves to receive the water of the pump below, and supply water to the pump above. The usual length for a set of mining pumps in 25 to 30 fathoms. At such intervals *cisterns* are placed.

3. (*Steam-engine.*) The vessel inclosing the condenser of a condensing steam-engine, and containing the injection water.

4. (*Glass.*) The receptacle into which glass is ladled from the pots to be poured on the table in making plate-glass, or in casting glass. A *cuvette*.

Cis'tern-fil'ter. A cistern having a permanent chamber which has filtering material intervening between the supply and discharge. In Fig. 1305, the water passes through the filtering material down one side of the vertical axial division, and, after passing beneath it, rises upon the other side.

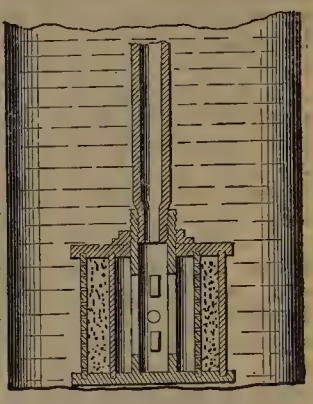
Fig. 1305.



Filtering-Cistern.

In Fig. 1306, the filter is at the lower end of the pump-stock. Two concentric cylinders are clamped between an upper and under disk, by means of an enlarged section of the pump tube. The annular space between the cylinders is filled with filtering material, and the cylinders are perforated on opposite sides, so that the water makes a partial circuit to reach the inner space which connects with the pump tube.

Fig. 1306.



Cistern-Filter.

Cis'tern-pump. A small pump, lift or force, for pumping water from the moderate depth of a cistern.

Cit'a-del. (*Fortification.*) An inner work capable of independent defence, but joined to the other works of a place.

Cith'a-ra. (*Music.*) An old kind of harp. The *cithern* is an Austrian stringed instrument. The *citole* is an instrument like the dulciner. The *citecn* is an ancient instrument resembling the lute. See CITTERN.

Cit'tern. (*Music.*) An old kind of guitar.

"My lord [Sandwich] called for the lieutenant's cittern, and with two candlesticks with money in them for symbols (cymbals), we made barber's music." — PEPYS, 1660.

Civ'er-y. (*Architecture.*) A bay or compartment of a vaulted ceiling. A *severy*.

Civ'il En-gi-neer'ing. See under the following heads: —

Adobe.
Alignment.
Anchor-gate.
Anchor-suspension cable.
Angle of repose.
Aqueduct.
Arch.
Arched beam.
Artesian well.
Asphalte pavement.
Auger.
Baleine.
Ballast.
Bank protector.
Banquette.
Basalting.
Batter.
Battering plumb-rule.
Battery-head.
Beam.
Bearing-pile.
Beché.
Bed.
Bench.
Berme.
Béton.
Bevel plumb-rule.
Blasting.
Blasting-needle.
Blinding.
Bolt and spike extractor.
Boring wells.
Bottoming.
Bowstring-girder.
Box-beam.
Breakwater.
Breast-wall.
Bridge (varieties, see BRIDGE).
Bridge-stone.
Buckled plate.
Cable. Submarine.
Cable. Suspension-bridge.
Caisson.
Camel.
Camp-shecting.
Canal.
Canal-lift.
Canal-lock.
Canal-lock gate.
Carpentry.
Causeway.
Cendreé de Tournay.
Centering.
Chemise.
Claw bar.
Cob wall.
Coffer dam.
Compo.
Concrete.
Conduit.
Construction way.
Corduroy road.
Counter-fort.
Coursed masonry.
Cradle.
Crevasses. Stopping.
Crosette.
Crow-bar.
Crow's foot.
Cuddy.
Culvert.
Curb.
Cutling.
Dam.
Dead-wall.
Detonating-primer.
Digue.
Dike.
Ditching-machine.

Diving-bell.
Dock (varieties, see DOCK).
Draining.
Drill.
Drum-curb.
Dualine.
Dumping-bucket.
Dynamite.
Earth-boring auger.
Earth-work.
Embankment.
Excavator.
Explorer.
Extension ladder.
False works.
Fascine.
Filling.
Finger-grip.
Fire-escape.
Fire-ladder.
Flood-gate.
Fulminate.
Gabion.
Gage-ladder.
Gavelock.
Girder.
Grab.
Grade.
Gradient.
Grading-post.
Grafting tool.
Grapnel.
Graving-dock.
Grillage.
Ground-mold.
Ground-plan.
Ground-plot.
Ground-work.
Grout.
Gulleting.
Gunpowder.
Half-lattice girder.
Horse power.
Horse run.
House moving.
Hydraulic engineering and devices.
Hydraulic mortar.
Inclined plane.
Jar. Boring.
Jetty.
Jumper.
Ladder.
Laminated rib.
Landing platform.
Lattice girder.
Lengthening rod.
Levee.
Level (varieties, see LEVEL).
Lewis.
Lift. Canal.
Lift-lock.
Lighthouse.
Lithofracteur.
Lock. Canal.
Macadamizing.
Masonry (see MASONS' AND BRICKLAYERS' TOOLS, etc.).
Metal.
Mill-dam.
Mining (varieties, see MINING).
Mole.
Monkey.
Mortar.
Nitrine.
Nitro-glycerine.
Nitroleum.
Notching.
Oil-well.
Pannier.
Paved way.
Pavement.
Paving.
Paving-machine.
Paving-roller.
Pebble paving.
Pick.
Pier.
Pierameter.
Pierre perdue.
Pile (varieties, see PILE).
Pile-drawer.
Pile-driver.
Pile-saw.
Pisé-work.
Pitched work.
Plank-road.
Polings.
Pozzuolana.
Praya.
Pricker.
Profile.
Propeller (varieties, see PROPELLER).
Pump (varieties, see PUMP).
Quadrel.
Quarrying-machine.
Rail (varieties, see RAIL).
Railroad (varieties, see RAILWAY-ENGINEERING).
Raising sunken vessels.
Ram.
Rammer.
Reamer.
Retaining wall.
Rising.
Road.
Road-making machine.
Road metal.
Road roller.
Road scraper.
Rock-crusher
Rock drill.
Roman cement.
Roofing composition.
Roofing machine.
Roof staging.
Roof truss.
Rounder.
Runner.
Saddle.
Sand scoop.
Sand pump.
Scaffold.
Scagliola.
Scarcement.
Scraper.
Screw-pile.
Sea wall.
Sewer.
Shield.
Shipwrighting (which see).
Shrinkage.
Side cutting.
Signal-tower.
Sinking.
Slackwater navigation.
Slating.
Slip.
Slope.
Sludger.
Snow-sweeper.
Spandrel.
Spoil.
Staging.
Staith.
Stall-boards.
Starling.
Steam-engine (which see).
Steining.
Stone. Artificial.
Street-railway.
Street-sprinkler.
Street-sweeper.
Street-watering.
Subterranean railway.
Sub-way.
Suspension bridge.
Suspension railway.
Swing bridge.
Talus.
Tamping.
Tamping-bar.
Tamping-plug.
Teaming.
Telo-dynamic cable.
Temoine.
Topit.
Torpedo for oil-wells.
Track-layer.
Traction engine.
Tramway for ferry-boats.
Tram-road.
Trass.
Trestle.
Truss.
Tube-extractor.
Tubular bridge.
Tunnel.
Tunnel-excavator.
Vault.
Vault-cover.
Vault-light.
Viaduct.
Water-elevator (which see).
Water-wheel (which see).
Well.
Well boring.
Well-drill.
Well packing.
Well-tubes, driven.
Well-tube filter.
Wharf.
Wing wall.
Wire way.

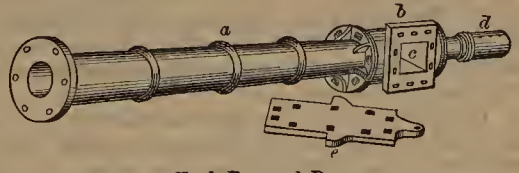
Clack. 1. (*Millwrighting.*) A device in grain-mills for ringing a bell when more grain is required to be fed to the hopper. A mill-hopper alarm.

2. A valve.

Clack-box. 1. In a locomotive, a ball-valve chamber attached to the boiler, and preventing the reflux of water in the feed-pipe.

2. The chamber of a clack-valve. The illustration shows the parts of a bucket-lift of a Cornish

Fig. 1307.



Clack Box and Door.

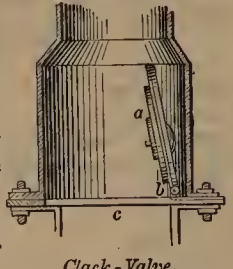
pump, lying upon the ground. It shows the working-barrel *a*, clack-box *b*, door *c*, and wind-bore.

Clack-door. (*Mining.*) The aperture through which the *clack* is fixed or removed.

Clack-mill. A noisy clapper urged by the wind, and intended to scare birds.

Clack-valve. A valve hinged at one edge, opened by the passing current, and clacking back on its seat by gravity.

Fig. 1308.



Clack-Valve.

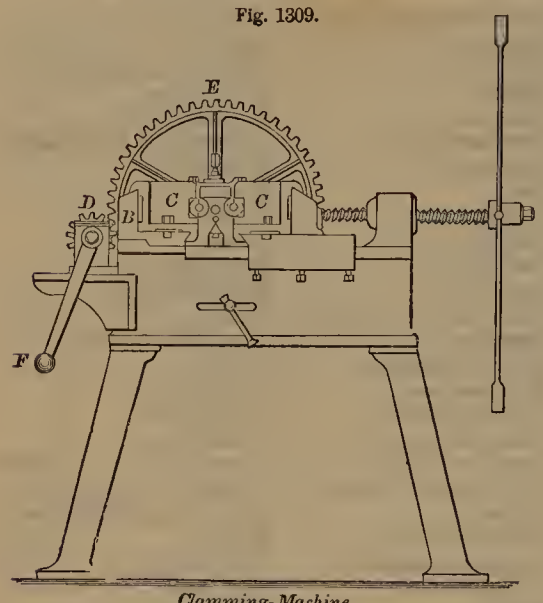
The butterfly-valve has two leaves hinged to a bar crossing the passage-way.

The valves of the feed-pump of a locomotive are technically called *clacks*, though they are frequently *ball*-valves.

a, valve; *b*, hinge; *d*, seat.

Clam'ming-ma-chine'. A machine in which an engraved and hardened *die* (*intaglio*) is made to rotate in contact with a soft steel *mill*, in order to deliver a cameo impression thereupon. The *mill* is used to indent copper rollers for calico printing. It

Fig. 1309.



Clamming-Machine.

is the same system as that used in the American bank-note engraving, and was invented by Jacob Perkins.

The mill is cylindrical, and is journaled in bearings attached to the beadstock *B* of the machine. The cylindrical die is journaled in the sliding-piece *C*. The mill, having been adjusted in its bearings, is forcibly screwed up against the die, to which motion is imparted by the gears *D E* operated by the winch *F*.

Clamp. 1. A pile of bricks built up together in order to be burned.

2. (*Metallurgy.*) A pile of ore heaped for roasting, or of coal for coking.

3. (*Joinery.*) *a.* A frame with two tightening screws by which two portions of an article are tightly compressed together, either while being formed, or while their glue joint is drying. (*b*, Fig. 1310.)

b. A back batten inserted or attached crosswise to unite several boards and to keep them from warping. Otherwise called a *key*.

4. (*Shipbuilding.*) The internal planking of a ship under the *shelf* on which the ends of the deck-beams rest. In vessels of war, the *clamp* is the planking above the ports, and the *spirketing* that below the ports. See SPIRKETING.

5. (*Ordnance.*) One of the hinged plates over the trunnions of a gun, usually called *cap-squares*.

6. (*Machinery.*) One of a pair of movable checks of lead or copper covering the jaws of a vise, and enabling it to grasp without bruising.

7. (*Saddlery.*) See SEWING-CLAMP ; STITCHING-CLAMP.

For varieties of clamps, see under the following heads : —

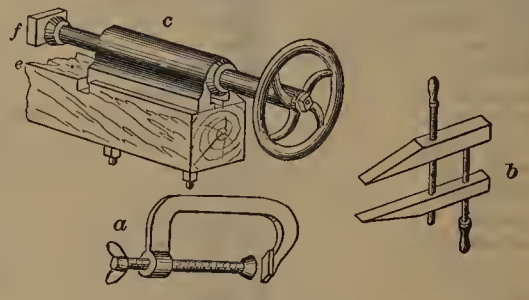
Axle-clamp.
Bench-clamp.
Book-clamp.
Castrating-clamp.
Claw for suspending tackle.
Clutch.
Flask-clamp.
Floor-clamp.
Grinding-clamp.
Harness-clamp.
Hitching-clamp.
Holdfast-clamp.
Joiners' clamp.
Lathing-clamp.
Line-clamp.
Molders' clamp.
Newspaper-clamp.
Pipe-clamp.
Planking-clamp.
Rigging-clamp.
Rope-clamp.
Rope-clutch.
Saw-clamp.
Sail-clutch.
Screw-clamp.
Sewing-clamp.
Stitching-clamp.
Stopper. Cable.
Strap-clamp.
Tourniquet.
Vise-clamp.
Weather-boarding clamp.

Clamp'er. A metallic shoe for a boot-heel, having calks to prevent slipping on ice. An *ice-creeper*.

Clamp-nail. (*Shipwrighting.*) A large kind of nail used to secure the clamps to the ribs of a ship.

Clamp-screw. A joiner's implement, on the bench, or to be attached to the work, for holding work to a table, or two pieces together.

Fig. 1310.



Clamp-Screw.

Clap'board. (*Carpentry.*) (Ger. *klapp-bord.*) A term irregularly used. It means : —

1. A weather-board on the side of a house, laid on, lapping the one beneath it, clinker fashion.

2. A roofing-board larger than a shingle and not usually shaved. A common size is a riven-board 48 inches long, and 8 inches broad. They are rived in the direction of the medullary rays, and the edge toward the heart is the thinner of the two.

3. In East England, a plank ; a cask-stave.

Machines are constructed for riving, sawing, planing, and gaging clapboards.

Clap'board-gage. A device used in putting on the weather-boarding of a house so as to leave a uniform width of face to the weather. The gage takes its set from the lower edge of the board last nailed on, and has a stop for the lower edge of the board next above.

Clap-net. A net in hinged sections which close upon the game.

Clap'per. A part which strikes, as : —

1. The tongue of a bell.

2. (*Mill.*) The clack which strikes the mill-hopper.

3. A piece of board to pat bricks to correct any warping when partially dried, in removing from the floor to the hack.

4. A clack-valve.

Clap'per-valve. (*Steam-engine.*) A valve suspended from a hinge and operating on two openings or seats alternately. In a modified form, it consists of a disk vibrating between two seats. A clack-valve.

Clap-sill. (*Hydraulic Engineering.*) The bottom part of the frame on which the lock-gates shut. The *miter-sill ; lock-sill*.

Clar'ence. A close single-seated carriage with a driver's seat in front.

Clar'i-bel'la. (*Music.*) A stop in an organ.

Clar'i-fi-ca'tion. The clearing of liquids by chemical means, as opposed to *filtration*.

Clarifiers or *finings* act by : —

1. Embracing the feculent matter and subsiding with it to the bottom of the vessel. Or : —

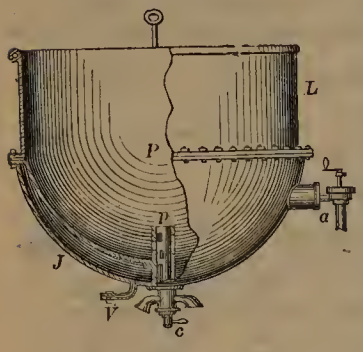
2. By inducing a change in the character of the liquid by which the feculencies are deposited as sediment.

The usual clarifiers are : —

Albumen, gelatine, acids, salts, blood, lime, plaster-of-paris, alum, heat, or alcohol.

Clar'i-fi-er. (*Sugar.*) A metallic vessel in which cane-juice is purified by heating and treatment with lime.

Fig. 1311.



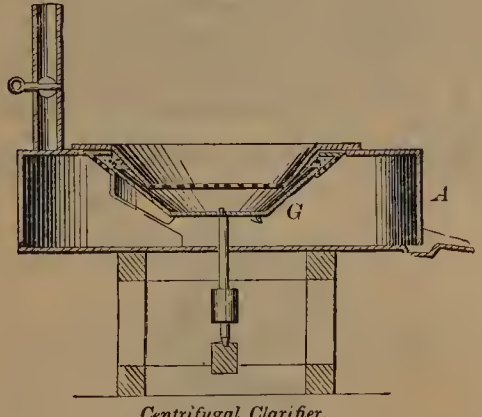
Clarifier.

It consists of a hemispherical copper pan *P* and a cast-iron jacket *J*, the intervening space being filled with steam by the pipe *V*. A pipe is used for conducting off condensed steam, and *a* is a faucet by which air escapes when the jacket is first charged with steam. The cylindrical upper portion *L* of the pan is to keep the scum from frothing over. The plug *p* in the bottom of the pan is furnished with two or three holes, down either of which the contents of the pan may be discharged by the appropriate movement of the valve-handle beneath.

The *clarifier* being filled with juice, steam is admitted to the jacket and the temperature raised to 174°. After skimming, milk of lime is added to neutralize the acid in the juice, the process being tested from time to time by litmus paper. A thick scum rises to the top, and the heating is continued until the scum is about to break, when the steam is shut off, the juice allowed a few minutes to settle, and the middle portion or clear liquid is removed by turning the handle of the cock *c*, which opens a hole three inches from the botton of the pan. As soon as scum begins to appear the discharge is stopped. The plug *p* is then removed, when the scum and sediment pass out of the pan and are placed in bags which, by pressure, yield the remaining juice.

In the clarifier shown in Fig. 1312, the centrifugal force generated by the rapid rotation of the strain-

Fig. 1312.



Centrifugal Clarifier.

er *G* causes the juice to flow up to and discharge through the perforations around its upper edge, whereby it is effectively brought in contact with the gas which pervades the curb *A*. The jets of juice are met by currents of gas, produced by the vanes.

Clar'i-fy-ing. The process of removing feculent matter from saccharine juices by heating, skimming, and precipitation. See CLARIFIER.

Clar-i-net'. (Ital. *clarinetto;* Fr. *clarinette.*) A reed instrument used in bands. Its name from *clarus* (Latin), clear, signifies a certain dominance of tone, and truly it emits an importunate sound. It is played by means of holes and keys, opened and closed by the fingers, after the manner of a flute. It was invented by John Denner in Leipsic, A. D. 1600. The double clarinet of the Arabs is termed a *zoomara.*

Clar'i-on. (*Music.*) *a.* A trumpet with a narrow tube, and having an acute and shrill tone. It was introduced by the Moors into Spain, A. D. 800.

b. A stop of an organ having metallic reed pipes tuned an octave higher than *trumpet;* in unison with *principal* and *flute.* See STOP.

Clasp. 1. A catch or fastening for a belt, the covers of a book, etc.

One part has generally a plate, which is bent over to form a hook, and the other has a wire on which the hook engages.

A belt-clasp is sometimes merely a hook and eye on the respective parts. See BELT-COUPLING.

2. (*Spinning.*) A device consisting of two horizontal beams, the upper one being pressed upon the lower one, or lifted, for drawing out the thread of cotton or wool.

3. A little bent plate which fastens two objects together, as the clasps which attach the wires to the tapes of hoop-skirts.

Clasp-hook. 1. A pair of hooks moving upon the same pivots, and forming mousings for each other.

Fig. 1313.

Clasp-Hook.

2. A tongs, whose jaws *a* overlap upon each other. The running ring *b* is the *reins.*

Clasp-knife. A large knife, the blade of which shuts into the handle.

Clasp-lock. A lock on the clasp which unites the two flaps of a book-cover.

Clasp-nail. A square-bodied, sharp, wrought nail, whose head has two pointed spurs that sink into the wood.

Clav'e-cin. (*Music.*) A harpsichord. A prostrate harp whose strings were agitated by plectra operated by keys.

Clav'i-chord. The *clavichord* was one of the predecessors of the *piano-forte.* Like the latter, the strings were *struck;* unlike the *harpsichord* and *spinet,* in which the strings were vibrated by a quill.

The string was struck by a vertical pin-wire, when the key was depressed. The sonorous vibration was modified by a *muffler,* consisting of a strip of cloth. This also gave a certain softness to the tone. The whole was enclosed in an oblong case. See PIANO-FORTE.

We read of a clavichord having forty-nine stops (keys?) and seventy strings, which bore upon five bridges, the first being the highest, and the others diminishing in proportion.

The clavichord used in concerts about A. D. 1589 had been known for some centuries; it was a flat rectangular box having twenty keys, embracing two and a half octaves, the semitone *B* flat being introduced in addition to the seven tones of the diatonic scale. The instrument had no legs, and was supported on a table. It may be considered the precursor of the square piano. It is probable that there were not so many strings as keys, the strings being shortened, as in a guitar, by a device brought into action by the movement of the key, which struck the note.

We read in a Leipsic work of 1600 of an instrument brought by Prætorius from Italy to Saxony, in which each key had its own string. This was considered quite a novelty in a keyed instrument, though common enough in harps, and was not fol-

lowed till long afterwards, probably the latter half of the eighteenth century.

Clav'i-cith-e'ri-um. (*Music.*) An old form of upright stringed instrument played by means of keys. It was used early in the sixteenth century, and has by some been supposed to be the same as the *virginal* (which see). The *clavicitherium* may be considered the precursor of the upright piano. It was modeled upon the *cithara*, and preserved a harp shape. It was comparatively light, and was rested on a table or the knees while playing.

Clav'i-cym'bal. Prætorius, who wrote in the sixteenth century, describes a clavicymbal which he saw at Prague. It was the shape of a prostrate harp, or a grand piano without legs. Its compass was four octaves, with nineteen notes in each octave. The sharps and flats had separate keys; as, for instance, *e* sharp and *d* flat were separate with different tones; keys were also provided between *b* and *c* and *c* and *f*. *Clavicymbalum.*

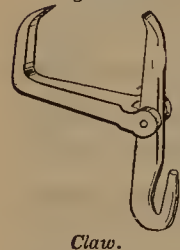
Cla'vi-er. (*Music.*) *a.* The key-board of an organ, piano-forte, or other instrument similarly played.

b. From Latin *clavis*, a key. The musical instrument of the sixteenth century, which consisted essentially of harps played by keys, were named from the latter feature CLAVICHORD; CLAVICYMBAL; CLAVICITHERIUM, etc. (which see).

Clav'i-ole. (*Music.*) A finger-keyed viol.

Claw. 1. (*Carpentry.*) *a.* A hammer with a bent and split peen to draw nails.

Fig. 1314.



Claw.

b. A little split tool for drawing tacks.

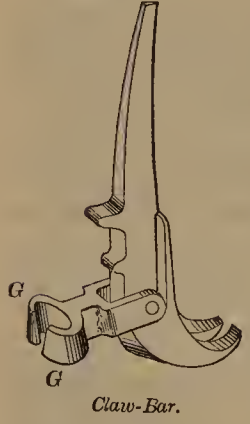
2. The bent and bifurcated end of a crow-bar; so also of the lifting-bar of a jack.

3. A bent hook on the end of a hoisting chain. A grapnel for suspending tackle. (Fig. 1314.) A hook-shaped tool.

4. (*Locksmithing.*) A spur or talon projecting from a bolt or tumbler.

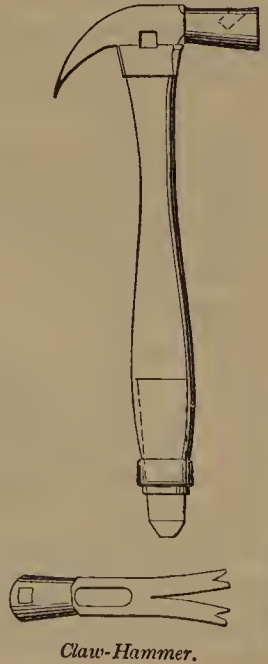
The essential feature is the talon or hook, and the word forms a part of many compound words, as —

Fig. 1315.



Claw-Bar.

Fig. 1316.



Claw-Hammer.

Claw-bar.
Claw-hammer.
Claw-jack.
Claw-wrench.
Rail-claw.
Tack-claw, etc.

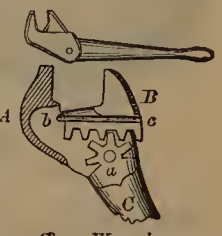
Claw-bar. A lever or crow-bar with a bent bifurcated claw for drawing spikes. The cut shows a supplementary shackle *G*, for reaching the heads of spikes in deep-seated depressions.

Claw-ham'mer. A hammer having a bifurcated bent peen, suitable for catching below the head of a nail to draw it.

Claw'ker. (*Knitting-machine.*) A feed-pawl or hand for a ratchet.

Claw-wrench. A wrench having a loose, pivoted jaw which binds of itself.

Fig. 1317.



Claw-Wrench.

Such are many of the forms of *pipe-wrenches* (which see).

In the one shown, the jaw *B* is made to approach jaw *A* by the engagement of the circular rack *a* on the handle with the rack *c* on the jaw *B*, so that the harder the strain on the handle the tighter the pinch.

Clay. A composition of silex or flint, mixed with alumina. The latter is usually about one fourth.

Porcelain clay is formed by the decomposition of a rock formed of quartz and feldspar.

Chinese *kaolin* consists of — silex, 71.15; alumina, 15.86; lime, 1.92; water, 6.73.

Cornish kaolin consists of — silex, 50; alumina, 50; lime, .1.

In the common acceptation of the term, clay is an earth which possesses sufficient ductility and cohesion, when kneaded with water, to form a paste and permit being fashioned by the hand, in a mold, or on a lathe.

Clayes. (*Fortification.*) Hurdles to form blinds for working parties. Reinforced with earth, they are substantially *gabions*, and as such are of a more permanent character.

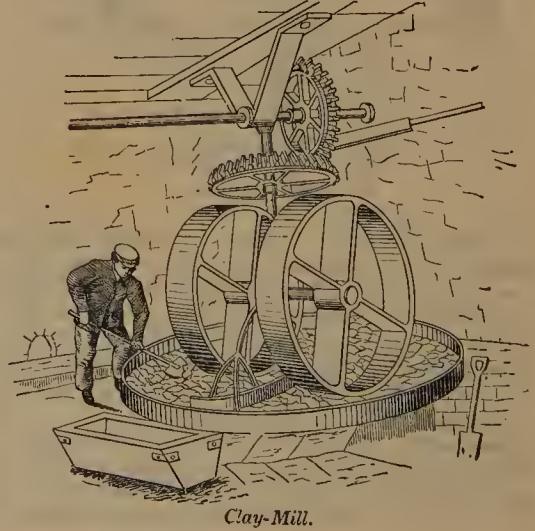
Clay'ing. 1. (*Sugar-making.*) A process in the crystallization of refined sugar in molds, in which a lump of wet clay is laid upon the base of the inverted cone of wet sugar, to secure the more perfect drainage of the coloring solution therefrom, by the prolongation of the process.

2. (*Mining.*) Lining the blast-hole with clay, to prevent the explosive becoming damp.

Clay'ing-bar. (*Mining.*) A cylindrical bar for driving tenacious clay into the crevices of a blast-hole, in order to prevent percolation of water on to the charge.

Clay-mill. A mill for grinding clay for bricks,

Fig. 1318.



Clay-Mill.

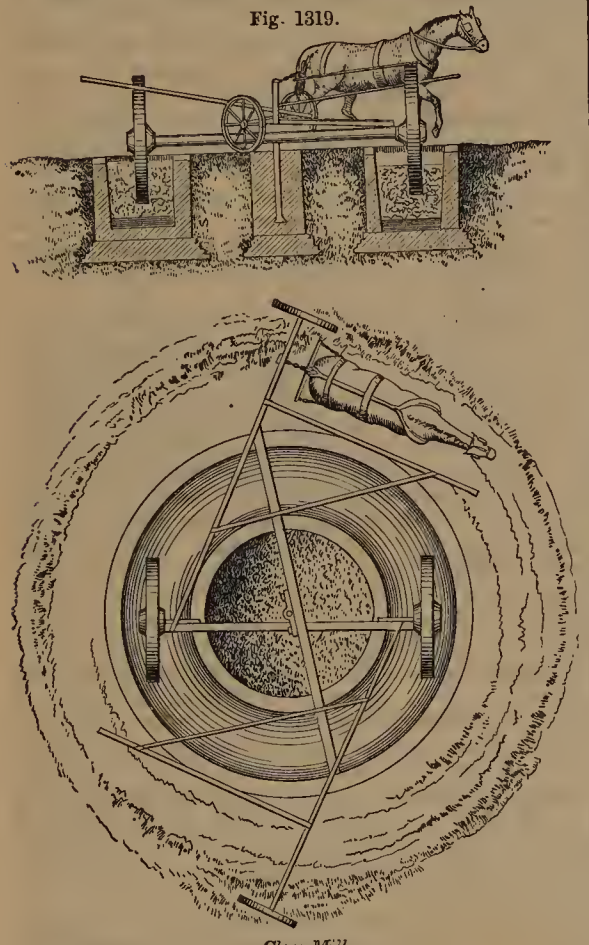
tiles, or the manufacture of pottery, stone-ware, porcelain, etc. The pug-mill is the form most usually employed. See BRICK-MACHINE; PUG-MILL.

In the South of England, at a famous clay-pit which supplies the potteries of London and Staffordshire, a form of Chilian mill is used. The dry clay is shoveled into a pan, which has a grated bottom; the runners rub and squeeze the clay so as to render it homogeneous, and mix thoroughly the clayey with the sandy particles with which it abounds.

To the upright shaft of the runners are attached two scrapers projecting as far as the rim of the bed-plate; the one is continually spreading the clay over the gratings, to allow the fine clay to pass through; and the other follows, collecting the coarser particles, and is so placed as to bring them again under the runners.

Another kind of mill may be used for working clay into mortar for bricks. It is used in England

Fig. 1319.



Clay-Mill.

for grinding chalk into pulp for adding to the kinds of clay deficient in lime, and is called a *crashing-mill*. Two of these mills are placed close together on a large double mound, sufficiently elevated to allow the *malm* to run down freely to the brick-earth. The chalk-mill is a circular trough lined with brickwork, in which the chalk is ground by the action of two heavy wheels with spiked tires, made to revolve by either one or two horses. The trough is supplied with water by a pump, the lever of which is worked by the machinery of the clay-mill, and as the chalk becomes ground into pulp it passes by a channel to the brick-earth with which it is incorporated in a pug-mill.

Clay'more. Formerly the two-handled sword of the Scotch Highlanders. Now a basket-hilted broadsword.

Clay-pipe. See TOBACCO-PIPE.

Clay-proc'ess. In this process clay is substituted for plaster in the process of making stereotype molds. The face of the type is forced into the clay by pressure. A plaster-mold, on the other hand, is formed by pouring the plaster on the type.

Clay-pul'ver-iz-er. A machine for grinding dry clay to render it more homogeneous previous to pugging.

Clay-screen'ing Ma-chine'. A machine for sifting pulverized clay. Used in preparing it for some of the finer ceramic manufactures.

Cleach'ing-net. A hand-net with hoop and pole.

Clead'ing. Plank covering or casing. As:

1. (*Mining.*) The boarding which lines a shaft or a tunnel.

2. (*Hydraulic Engineering.*) *a.* The planking of a dam or coffer-dam; or of a sea-wall, secured to guide piles, for instance.

b. The planking or skin of a canal lock-gate.

3. (*Steam-engine.*) The wooden covering of a steam-boiler or cylinder to prevent the radiation of heat. *Lagging.*

Clean'er 1. (*Leather.*) A currier's straight, two-handled knife, with a blade two inches broad.

2. (*Founding.*) A *slicker*. A tool used for smoothing surfaces in sand-molding.

3. (*Carding.*) One of a pair of small card cylinders called *urchins*, arranged around the periphery of a card-drum. The *worker* is the larger of the two; it takes the fiber from the card-drum and delivers it to the *cleaner*, which returns it to the card-drum. See CARDING-MACHINE.

Clean'ing-ma-chine'. (*Silk-manufacture.*) A machine in which silk thread is carried from bobbins over a glass or iron guide-rod, and then drawn through a brush in order to detach any particles of dust or dirt therefrom. To remove knots or bunches the thread is drawn through a notch in a bar of metal. When a knot refuses to pass through the opening, the plate is depressed, the bobbin lifted off the friction-roller which drives it, and, the attention of the operator being thus drawn to it, the knot or fluff is picked off and the bobbin again set in motion. See also COTTON-CLEANER.

Cleans'ing-vat. (*Brewing.*) A vessel in which the fermentation of beer is concluded; the yeast running out of the bung-hole, and being kept full by supply from a store-vat.

Clear'ance. (*Steam-engine.*) The distance between the piston and the cylinder-head when the former is at the end of its stroke.

Clear-cole. (*Painting.*) (From *clairè colle*, transparent size.) A priming coat prepared with size instead of oil.

In *oil-gilding*, a coat of clear-cole is laid on intermediate between the *white stuff* and the *oil gold-size*. See GILDING.

Cleare. The filtered fluid of coarse sugar decolorized by bone-black.

Clear'er. 1. A tool on which the hemp for sail-makers' twine is finished.

2. A rapidly revolving roller in the scribbling-machine laid alongside the *worker*.

Clear'er-bar. A bar in a horse hay-fork which throws the hay out from the teeth when the rake is lifted.

Clear-foun-da'tion Lace. Also called Lisle lace, from the French town of that name. A light, fine, transparent, white thread, hand-made lace. It has a diamond-shaped mesh formed by two threads plaited to a perpendicular line.

Clear'ing. 1. (*Silk-manufacture.*) The process of removing irregularities from silk filaments before spinning, by passing them beneath a scraper, or between steel rollers. See SILK-MANUFACTURE.

2. (*Calico-printing.*) Washing the dye solution from the unmordanted portion of the cloth, in the "madder style" of printing.

3. (*Machinery.*) The amount of play between the meshing-teeth of cog-wheels, to avoid jam.

Clear'ing-beck. (*Dycing.*) A vat in which cottons printed with certain colors are scoured with soap and water.

Clear'ing-pan. (*Sugar-manufacture.*) A CLARIFIER (which see).

Clear'ing-screw. In some fire-arms, a screw at right angles to the nipple, affording a communication with the chamber.

Clear'ing-stone. The fine stone on which the currier's knife receives its final whetting. It is first ground on the *rub-stone*. The knife has its edge turned over by a steel.

Clear-stuff. Boards free from knots, wane, wind-shakes, ring-hearts, dote, sap.

Cleat. (*Carpentry.*) 1. A strip of wood secured to another to strengthen it; as a batten placed transversely on the back of several boards which are jointed or matched together.

Fig. 1320

Cleats.

2. (*Nautical.*) A belaying piece, consisting of a bar with two arms fastened to a post or stanchion by a bolt passing through its stem.

a a, belaying-pins.
b, cleat.
d, belayed rope.
b' b'. cleats lashed to a stay.
e, belaying-pin splice.

3. An iron nailed to a shoe-sole to preserve it.

4. A trunnion bracket on a gun-carriage.

Cleav'er. A heavy, long-bitted chopping-tool, used by butchers in cutting up carcasses. In the pork-packing establishments of Cincinnati, Chicago, etc., it is used to the exclusion of other cutting tools, except in trimming. Two men with cleavers stand on each side of the block. One cut severs the head from the body; another severs the body at the loins, cutting off both hams; the third chops off the two hind feet; the fourth removes the two fore feet; a fifth divides the hams; two or three divide the middles and shoulders on the line of the backbone. It is more quickly done than told. Circular saws are now substituted in some establishments.

Cleav'ing-knife. (*Coopering.*) A tool used for riving juggles into staves, clapboards. A *froe*.

Cleav'ing-saw. A *pit*-saw; a *rip*-saw, as distinguished from a *cross-cut* saw.

Clench-bolt. One whose pointed end is clenched after passing through the wood, — sometimes over a washer or ring.

Clep'sy-dra. A *water-clock;* a *hydroscope*. The invention of the clepsydra was ascribed by the ancient Egyptians to *Thoth*, who is held to be the original Mercury. It was in use among the Egyptians, Chaldeans, Greeks, and Romans.

The name is derived from the simple form of a basin with a small hole in the bottom, which, being placed in a vessel of water, gradually filled and sank. This plan is said to be still used in India, and marks a time equal to about twenty minutes, called a *gurhee*. An Indian *clepsydra* of a different construction is mentioned in the arithmetical treatise of Bhas-cara, written in the twelfth century.

The clepsydra is thus described in the Sûrya-Siddhanta, a Sanscrit text-book on astronomy: — "A copper vessel, with a hole in the bottom, set in a basin of pure water, sinks sixty times in a day and night, and is an accurate hemispherical instrument." — Ch. xiii., s. 23.

The Chaldean astronomers used clepsydras as measurers of time, and they remained as accessories to astronomical observatories down to the time of Galileo.

The Chaldeans divided the zodiac into twelve equal parts by allowing water to run out of a small orifice during the whole revolution of a star, and dividing the liquid thus obtained into twelve parts. So says Sextus Empiricus. It is probable that the discharging-vessel was kept at a constant level, or otherwise equal quantities passing would mark unequal times as the pressure diminished. If the vessel were kept constantly full, it would discharge a quantity equal to its capacity in half the time it would empty itself unrenewed.

Athenæus, a distinguished Greek writer of the third century, A. D., a native of Egypt, in the course of his "table-talk" mentions that Plato (372 B. C.) had constructed a clepsydra or water-dial which played upon pipes the hours of the night, at a time when they could not be seen on the index.

Vitruvius dates the invention something over 100 years later, attributes it to Ctesibus of Alexandria, who lived under Ptolemy Euergetes, 245 B. C., and who states that water was made to drop upon wheels which turned and actuated a small statue having a stick in his hand. The figure rotated on its pedestal and pointed to the figures on a numbered circle. They were, however, known before Ctesibus, but it is probable that he applied toothed wheels to them. They were introduced into Rome by P. Cornelius Scipio Nasica, 157 B. C. The orators in Rome, in the time of Pompey, were limited to a certain time: as Cicero says, *latrare ad clepsydram*. It is supposed that among the Romans they consisted of a vessel from which the water issued drop by drop, falling into another vessel in which a rising float indicated against a graduated index the lapse of time.

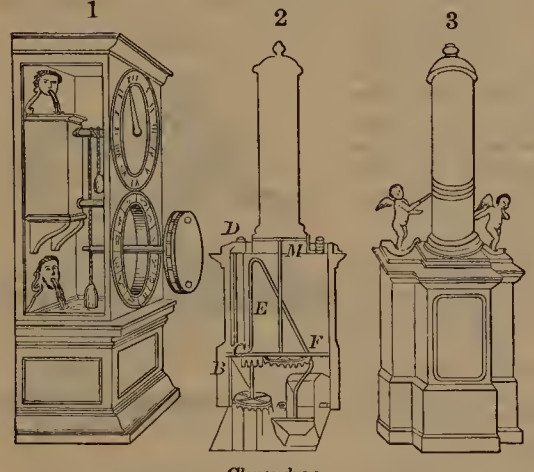
It may be that they used the *hour-glass*, a modified form of the *clepsydra*, sand being substituted for water, and under a gag or five-minute rule, the running out of the sand shut up the mouth of an orator who was disagreeable to the majority. The friends of Cataline, we may suppose, failed to enforce the rule against Cicero, whose friends moved for a suspension of the rules, and so we have *Quousque tandem abutere*, etc., the delight of compositors, and the horror of dull school-boys.

In the instrument of Ctesibus, 2, 3, Fig. 1321, the device for the measurement of the hours was a cylinder resting upon a pedestal; two figures were placed upon the latter, one of which dropped water from its eyes, while the other pointed with a wand to the hour marked on a vertical line drawn upon the cylinder. This cylinder turned on its axis once a year, and on it were drawn curved lines which

exhibited the inequality of the hours on different days, by their being marked at unequal distances.

The manner of working this machine was to allow the water to rise through a tube, which, passing through one figure, was discharged into a reservoir *M*, from which it passed into the pipe *B C D*. In this pipe a piece of wood floated upon the surface, and by its ascent, as the pipe filled, it raised the small pillar *C D*, on which the other figure rested, and as the float rose in the pipe the wand was made to point to the different hours. Every twenty-four hours the vessel became filled, as did the inverted siphon, which communicated with it. The water was then drawn off by the siphon, *E F*, and falling in its descent into the buckets of the wheel below, put that in motion. This wheel had six buckets, and therefore made one revolution every six days. Its axis carried a pinion of six teeth, working on another wheel of sixty teeth; this also carried another pinion of ten teeth, and drove a wheel of sixty-one teeth, which by its axis turned the pillar round once in 366 days. These machines indicate

Fig. 1321.



Clepsydras.

considerable hydrodynamical knowledge, and suggest some acquaintance of Ctesibus with Archimedes, who traveled in Egypt.

In the clepsydra shown at 1, Fig. 1321, the water from an upper reservoir, kept constantly full, passed through a pipe into a drum having apertures of various sizes corresponding to the length of the days at different seasons of the year. The flow was regulated by turning the drum so that its index should correspond with the proper division of a zodiac engraved on the face of the clepsydra. The water was discharged into a lower reservoir, on which floated an inverted vessel suspended from a chain passing around an axis upon which the hour-hand was fixed and counterbalanced. As the water rose, the vessel ascended, turning the hand on its axis and indicating the hour on a dial.

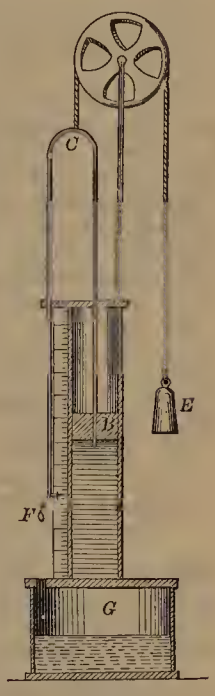
Clepsydras are said to have been found in use among the Britons by Julius Cæsar, 55 B. C.

The Saracens had several kinds of clepsydras; one with a balance.

A clock was presented by Pope Paul I. to Pepin, King of France, A. D. 760; was possibly a clepsydra. Pacificus, Archdeacon of Genoa, invented one in the ninth century.

Lately, the clepsydra has been adapted by Captain Kater, for the accurate measurement of short intervals of time, by the flowing of mercury from a small orifice in the bottom of a vessel, kept constantly filled to a certain hight. The stream is intercepted at the moment of noting any event, and diverted aside into a receiver, into which it continues to run till the moment of noting another event, when the intercepting cause is suddenly removed and the stream turned to its original channel. The weight of mercury in the receiver in comparison with the known rate of passage determines the interval between the events.

Fig. 1322.



Clepsydra.

Professor Airy, Astronomer Royal of England, has applied the clepsydra to communicating motion to telescopes equatorially mounted.

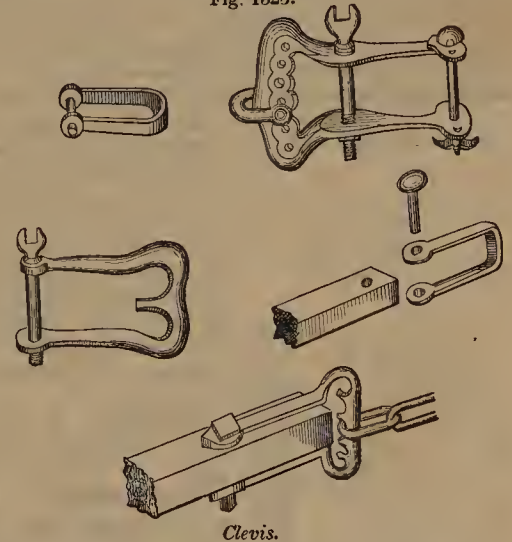
Partington's clepsydra is constructed to discharge equal quantities of water in equal times. *B* is a float on the surface of the water, and *E* is a weight to counterbalance the weight of the siphon *C*, and its contained water. The water is discharged at *F*, the lower end of the long leg of the siphon, and is collected in the box *G*, which forms the base of the instrument.

The Chinese clepsydras are described in the United States Agricultural Report, 1851, plate at the end of the book. The description in the Mechanical Report of the Patent Office, same year, pp. 335, *et seq.*

Clere-sto'ry. That upper portion of the middle aisle of a Norman or Gothic cathedral church which shows above its side aisles, and has a tier or row of windows on each side looking clear over the side-aisle roof. A *clear-story*.

Cle'vis. A stirrup-shaped metallic strap, used

Fig. 1323.



Clevis.

in connection with a pin to connect a draft-chain or *tree* to a plow or other tool.

The illustration shows several forms for vertical and horizontal adjustment, for plows, double-trees, shovel-plows, etc.

Clew. (*Nautical.*) *a.* A lower corner of a square-

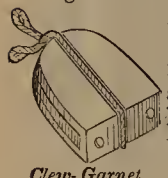
sail ; the aftmost corner of a fore-and-aft sail. The *clewlines* are attached to the clews of a square-sail, and draw the latter up to the yard in furling. The *sheets* are attached to the same corners, and expand the sail.

b. The lines fastened to the ends of a hammock and meeting at the *grommets*, to which are attached the lanyards by which the hammock is suspended from rings or hooks in the deck-beams.

Clew-gar'net. (*Nautical.*) A tackle attached to the clew of a lower square-sail, to haul it up to the yard in furling.

Clew-gar'net Block. (*Nautical.*) A block with a single sheave, and strapped with two eyes, which are lashed together above the yard.

Fig. 1324.



Clew-Garnet Block.

When double, the foremost sheave is for the top-gallant clewlin and the after one for the royal sheet The leading part of the fall follows down the mast to the deck.

Clew'line. (*Nautical.*) A rope for hauling up the clew of an upper square-sail.

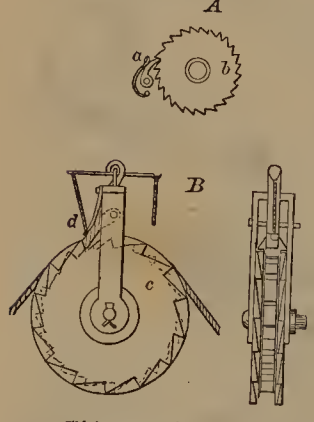
Cliché. (*Printing.*) *a*. The process of obtaining a matrix or cast *in intaglio* from a form of type, so that a cast in metal in cameo may be obtained therefrom for printing purposes. The usual material for newspaper work is papier-maché, or paper in sheets. When the latter material is used, it is dampened and laid upon the form, the thickness of paper, number of sheets, and degree of dampness, being a matter of experience and skill. A stiff brush is then dabbed over the surface in such a manner as to force down the paper between the type, so as to obtain a perfect mold. This is then dried, backed to give it the necessary rigidity, and forms a mold on which a stereotype-plate is cast.

b. A mode of obtaining an impression from a die in high relief, or from a form of type, by striking the cold die with a sudden blow upon a body of metal which is just becoming solid.

Click. The detent *a*, of a ratchet-wheel *b* (Fig. 1325), falling into the spaces between the cogs as the wheel revolves in one direction, and preventing the backward motion of the wheel. The name is no doubt derived from the sound. It usually acts by spring, sometimes by gravitation. In larger machines it becomes a *pawl*, as in the capstan.

Click-pul'ley. The rim of the sheave *c* (Fig. 1325, *B*) has notches, engaged by a spring click *d*, which acts as a detent to restrain the sheave from running back. The groove of the sheave is toothed to prevent the slipping of the rope therein. The click is raised by a trigger and cord when required.

Fig. 1325.



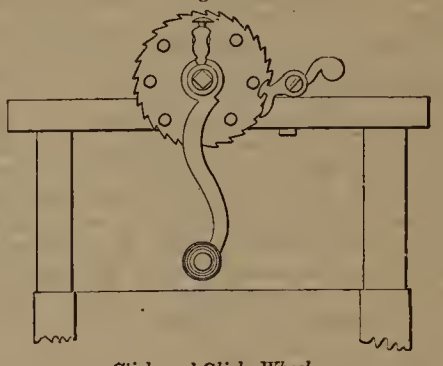
Click and Click-Pulley.

Click'et. A latch-key ; the latch of a door.

Click-wheel. A wheel whose cogs are radial on one face and inclined on the other, so as to give a square face to the end of the *click*, *pawl*, *ratchet*, or *detent*, which prevents the back movement of the wheel. A ratchet-wheel.

Climb'er. 1. (*Telegraphy.*) A boot provided with spurs, by which a person is enabled to climb telegraph-poles to make repairs or additions to the wires or insulators.

Fig. 1326.

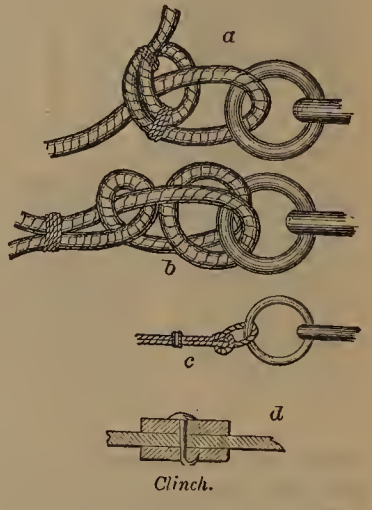


Click and Click-Wheel.

2. (*Railroad Engineering.*) A driving-wheel of a locomotive, having a positive grip, as by cogs or pinchers, upon a rail or rack in ascending or descending grades.

Clinch. 1. (*Nautical.*) A mode of fastening large ropes, consisting of a half-hitch with the end stopped back to its part by seizings. The *outer end* of a *hawser* is *bent* by a *clinch* to the *ring* of the *anchor*.

Fig. 1327



Clinch.

a, slip-clinch.
b, clinch secured.
c, simple clinch.

The knot of the breeching, which secures the gun to the ring-bolts on the side of the gun-port.

2. A fastening, *d* (Fig. 1327), in which the long end of a nail is turned over and the recurved end caused to enter the material so as to oppose retraction.

Clinching is distinguished from *riveting*, as the metal in the latter process is swaged down either against the object or upon a washer.

3. (*Farriery.*) The turning over and beating down of the end of a horseshoe nail, against the wall of the hoof, to prevent retraction.

Clinch-built. See CLINCHER-WORK.

Clinch'er. A tool for clinching, — that is, turning over the pointed end of a nail so as to prevent its retraction.

In wood, the end is bowed over and driven into the piece through which the nail last passed.

In farriery, the end of the horseshoe nail is nipped off and the stub battered down so as to oppose a hooked, flattened portion, against the action of withdrawal. After the nail has been driven by a hammer in the ordinary way, one jaw is placed upon the head of the nail, and the other jaw is brought up to engage with and flatten down the point of the nail.

Clinch'er-built. See CLINCHER-WORK.

Clinch'er-work. 1. *Lap-jointed* work. A mode of building in which the lower edge of each plank overlaps the one next below it, like the

weather-boarding of a house ; the shingles or slates of a roof.

The term is variously compounded : *Clincher-build*, *clincher-plating*, *clincher-work*, and, erroneously, *clinker-work*.

The root of the word *clinch* is to grasp or fasten, and the feature of the joint is a lap or fold. *Clink* is an onomatopoetic word derived from the sharp sound of a vitreous body when struck ; hence *clinker*.

Clincher-work is used on boats of a lighter description, — the galley, gig, cutter, jolly-boat, dingy, etc. (See BOAT.) The lower edge of each strake of plank overlaps the upper edge of the next strake below. They are not built upon frames, but upon temporary transverse sectional molds, two, three, and four in number, which are fixed at their proper stations on the keel. The strakes are then put on, beginning with the garboard strake, and bent to the figure given by the molds. Each strake is fastened to the next below it by nails, driven from the outside through the laps or *lands*.

When two or more lengths of plank occur in a strake, they are scarfed to each other, the outside lap of each scarf pointing aft. The scarfs have a layer of tarred paper between, and are fastened with nails driven from the thin end of each piece.

2. A mode of uniting the iron plates of vessels, tanks, or boilers, in which the edges are *lapped*, and secured by one row of rivets. It is distinguished from *carvel*-build, in the respect that in the latter the edges of the plates are brought together and the joint covered by an interior *lap* or *welt*, to which the plates are secured by two rows of rivets, one to each plate.

Clinch'ing. (*Nautical.*) Slightly calking the seams round the ports with oakum, in anticipation of foul weather.

Clinch'ing-iron. See CLINCHER.

Clinch-joint. See CLINCHER-WORK.

Clinch-ring. A lap-ring or open ring, in which the parts on the sides of the opening overlap each other.

Clin'i-cal Ther-mom'e-ter. (*Surgical.*) A thermometer with a long bulb on a bent arm. The straight portion only is attached to the index-plate, which has a range from 80° to 120°. In use, the bulb is inserted in the axilla, or the mouth. The instrument is self-registering, and is graduated to fifths of degrees.

Clink'er. 1. A brick whose surface is vitrified by the extreme heat of the fire.

2. A description of Dutch brick.

3. A scale of oxide of iron formed in forging.

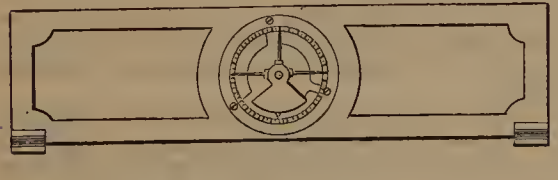
4. A mass of incombustible vitrified scoriæ or slag, clogging a furnace.

Clink'er-bar. A bar fixed across the top of the ash-pit to support the *slice* used for clearing the interstices of the bars.

Clink'er-built. See CLINCHER-WORK.

Cli-nom'e-ter. 1. An instrument used in determining the slope of cuttings and embankments. It has a quadrant graduated to degrees and fixed at the end of a long bar which is laid adown the slope ; an index turns upon the center of the quadrant, to which a spirit level is attached. The level being set horizontally, the angle of the same will be indicated on the quadrant as the latter partakes of the motion of the rod. A *batter-level*.

Fig. 1328.



Clinometer and Level.

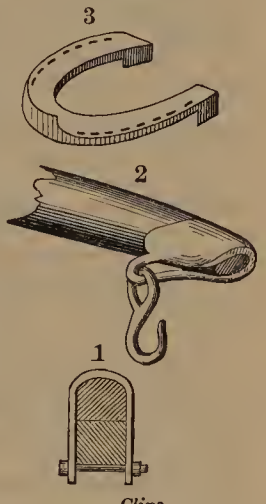
2. A carpenter's tool for leveling up sills and other horizontal framing timbers.

That illustrated is a combined clinometer, plumb, and level, and has a vertical circular box, with an arrangement of scales so graduated as to give, in connection with one or more index fingers, the amount of deflection of an object from a vertical or horizontal position, in both circular and linear measurement.

Clin'quant. A meretricious alloy ; yellow copper ; Dutch-gold. See ALLOY.

Clip. 1. An embracing-strap to connect parts together, as in the case of *clips* on the axle which connect the springs thereto.

Fig. 1329.



Clips.

The wheels of the ancient Egyptian chariots had strengthening clips of bronze at the junction of the spokes and fellies. The wheels were of small diameter, and not of very strong construction. Metal was sparingly used.

2. An iron strap on a double or single tree, with a loop by which either is connected to the plow-clevis, the trees to each other, or the traces to the single tree.

3. A projecting flange on the upper surface of a horseshoe which partially embraces the wall of the hoof.

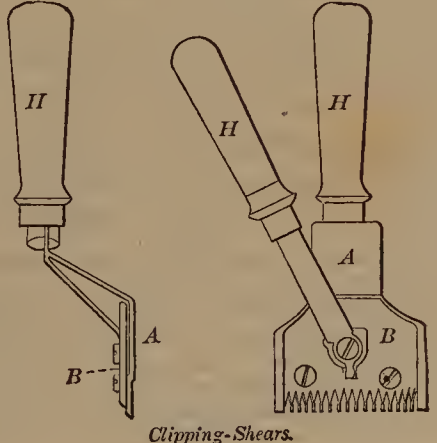
Clip'per. 1. (*Nautical.*) A fast-sailing vessel, constructed on fine, sharp lines ; built especially for speed rather than cargo.

2. A machine for clipping hair. It is especially used for horses, and in England more than in any other country. One form has a stationary knife and several spiral knives on an axis, acting against the edge of the former. A comb is so arranged as to determine the length to which the hair is cut.

A more usual form has a serrated knife reciprocating shearwise, with a similar plate, stationary, or also reciprocating.

Clip'ping-shears. Shears for clipping horses,

Fig. 1330.



Clipping-Shears.

having a guard which gages the length of hair remaining. One form is shown in Fig. 1330, in which the serrated knife *B* is reciprocated above the serrated plate *A* by means of the handle *H*, the hairs which come between the teeth being severed thereby. A number of cutters are so arranged on a comb that the length of hair left, in clipping, may be regulated, and the cutters are guarded by said comb so that the skin of the animal cannot be injured.

Clip-plate. (*Carriage.*) The axle-band of a wheel.

Clis'e-om'e-ter. (*Surgical.*) An instrument for measuring the angle which the axis of the female pelvis makes with that of the body.

Clives. A hook, with a spring to prevent its unfastening.

Clo-a'ca. A sewer. The word is Latin, and has been long celebrated in reference to the *Cloca Maxima*, the main sewer of ancient Rome, coustructed by the Tarquins, and yet serviceable.

Clock. An instrument, — differing from a watch in not being adapted to be carried on the person, — and having a motive weight or spring, a train of gearing, index-hands, and figured dial, and a pulsative device to determine the rate at which the mechanism shall move.

Before the invention of mechanism by which a rate of motion of a staff or pointer was made to indicate periodic lapse of time, the shadow of the sun in his apparent daily progress enabled the observation of the passing hours. A gnomon, erected so as to throw its traveling shadow across a graduated arc, constitutes a dial, though many considerations intervene between the mere post-shadow which cuts the mark upon the sand, and the dial whose readings will suit the varying circumstances of the earth in its solar relations at the solstices and the equinoxes. See DIAL.

First the dial and then the clepsydra, is the apparent order; the latter is a mechanical time-indicator (see CLEPSYDRA), but not a clock, if the meaning of the latter term — to strike, to beat — is to constitute the distinction; the *cluck-cluck* of a hen, and the *click-click* of a ratchet-wheel, are the lingual allies of the *clock*, whose pendulum gives the rate of the tick-tick made by the contact of the scape-wheel teeth with the pallets.

The graduated face-plate with figures belonged to the *dial* long before the time of *clocks*, which are audible in their very name and nature, and the name *dial* is now very properly applied to the face of a clock or watch, as their duties are (Latin, *dialis*) daily. We have no record that goes back of the division of the circle into degrees, and the early dials were thus divided. Perhaps the vigesimo-quartal division of the dial was derived from the Chinese, for their compass had many centuries ago a number of divisions representing the cardinal and intermediate points, and also certain divisions of the natural day. The division of the Chinese compass into twenty-four points, marking periods of the natural day equal to 15° of the circle, was probably derived from the supposed number of days ($24 \times 15 = 360$) occupied by the sun in its (apparent) course through the heavens. See DIAL.

Most nations, we may suppose, had some definite mode of marking divisions of diurnal time; with the Jews the time between sunrise and sunset was divided into twelve periods, which were therefore longer at the summer solstice than at equinoxes, and longer at the latter than at the winter solstice. This complicated the construction of "the dial of Ahaz" referred to by Hezekiah, and which was probably brought from Damascus by Ahaz; we know that he obtained the pattern of an altar from thence. We read (Daniel iv. 19) that Daniel "was astonished for one hour," Chaldean time, which is not astonishing, considering the critical nature of the message he had to deliver. Distinct intimation of the hours is given in connection with the setting up of the dial in the Quirinus at Rome, 293 B. C. The hours were called through Rome by public criers, as they were at night by watchmen, within the memory of some of us.

"They return at evening; they make a noise like a dog, and go round about the city." — Psalms lix. 6.

Clocks are not very common in China, being mostly confined to the public offices, where it is common to find half a dozen all in a row.

The Chinese divide the day into twelve parts of two hours each. The Italians reckon the twenty-four hours round, instead of dividing them into two sections of twelve hours each, as we do. The Mexican day was divided into sixteen hours or periods.

The early expedient in England was wax tapers, invented by Alfred the Great, A. D. 886. It appears that even hour-glasses were not then known in England, though they are regarded as very ancient, and were certainly known in Rome long previously.

The first "striking" or audible notification of the hour, on record, is the clepsydra or water-dial of Plato, 372 B. C., which, by the agency of water, sounded upon organ-pipes the hour of the night when the index could not be seen. The contrivance is mentioned by Athenæus of Egypt, a distinguished Greek writer of the third century, and author of the "Deipnosophistæ." See CLEPSYDRA.

Wheel-work set in motion by springs and weights was known in the time of Archimedes (287 – 212 B. C.), and applied to mechanical engines and toys.

The graduated dial, the shadow of the gnomon marking hours, was known in Rome 293 B. C.

Two more things were necessary to make a clock: —

1. To join the wheels to a pointer which traversed the dial.

2. To contrive a mode of regulating the speed of the going works.

When these two features were united to form a clock is not known.

The early indications are as follows: —

A. D. 760, a clock presented by Pope Paul I. to Pepin, of France: probably a clepsydra.

A. D. 810, the clock sent by the Khalif Haroun al Raschid to Charlemagne is believed to have had some kind of wheel-work, but to have been impelled by the fall of water. In the dial were twelve small doors forming the divisions for the hours, each door opened at the hour marked by the index, and let out small brass balls, which, falling on a bell, struck the hours. The doors continued open until the hour of twelve, when twelve figures, representing warriors on horseback, came out and paraded around the dial-plate.

Pacificus, Archdeacon of Verona, seems to have improved the clock.

A. D. 1000, Ebu Junis, of the University of Cordova, had a *pendulum*-clock; to which Gerbert is supposed to have added the *escapement*. See PENDULUM.

The balance clock described by Al Khâzinî, twelfth century, consisted of a beam suspended on an axis a little above its center of gravity, and having attached to one of its arms a reservoir which,

by means of a perforation in its bottom, emptied itself in twenty-four hours. The reservoir was poised by other weights which slipped down their arm as the discharge of water lightened the other arm, and the place of the weights marked the lapse of time.

Where the period of the clepsydra terminated, and that of weight-driven clocks commenced, cannot now be determined, but it is certain that the clocks of the Spanish Saracens were driven by weights. The renowned Gerbert studied philosophy and common-sense at the Saracenic University of Cordova, became successively a schoolmaster at Rheims (where he had a clock), Archbishop of Ravenna, and Pope Sylvester II., to which latter dignity he was advanced by the Emperor Otho III. ; and they died by poison, both of them.

To follow up the recital : —

A. D. 1288, a clock was placed in the old palace yard, London, and remained till the reign of Queen Elizabeth.

A. D. 1292, a clock was placed in Canterbury Cathedral.

A. D. 1300, Dante refers to a clock which struck the hours. Chaucer refers to the *horologe*.

No certain mention is made, up to this time, of the means of regulating the speed of the machine, and that the pendulum had not been adopted to any extent, is certain.

It may be presumed that the device used was a *fly* (see Fly); a wheel with vanes which impinged upon the air, the latter affording a resistance proportioned to the size, number, radius, angle, and speed of the vanes. Such was the case probably with : —

A. D. 1380, the clock erected by Richard of Wallingford; abbot of St. Albans.

During the same century a pulsating regulator was introduced into France.

A. D. 1364, Henry de Wyck, or de Vick, a German, erected a clock in a tower of the palace of Charles V., at Paris.

A. D. 1368, a striking clock was erected at Westminster.

A. D. 1370, clocks at Strasburg and Courtray, after which they became quite common.

The pulsating arrangement of Henry de Wyck consisted of an alternating balance, which was formed by suspending two heavy weights from a horizontal bar fixed at right angles to an upright arbor, and the movement was accelerated or retarded by diminishing or increasing the distance of the weights from the arbor.

This clock, which had no regulating spring, was the type of the astronomical clocks used by Tycho Brahe (1582), and by many less illustrous but worthy and useful observers, at and about the same date.

Clocks were in possession of private persons about 1500, and about the same time watches were introduced.

Shakespeare refers to a watch in the play of *Twelfth Night*, where Malvolio says : — "I frown the while, and perchance wind up my watch, or play with some rich jewel."

"Mr. Pierce showed me the Queene's [the Portuguese princess, wife of Charles II.] bedchamber, and her holy-water at her head as she sleeps, with a clock by her bedside, wherein a lamp burns that tells her the time of the night at any time."— *Pepys's Diary*, 1664.

The pendulum, which engaged the attention of the Spanish Saracens in the eleventh century, and persons of other nations who were so fortunate as to visit their University of Cordova, had a sleep of six centuries, for it was reserved for the seventeenth century to bring it into general notice and usefulness.

Early in the seventeenth century, Galileo, observing the oscillations of a suspended lamp, conceived the idea of making a pendulum a measurer of time, and in 1639 published a work on mechanics and motion, in which he discussed the isochronal properties of oscillating bodies suspended by strings of the same length.

A. D. 1641, Richard Harris constructed a pendulum clock in London, for the church of St. Paul, Covent Garden.

A. D. 1649, a pendulum clock was constructed by Vincenzio Galileo (the younger Galileo).

A. D. 1650, Huyghens constructed clocks on this principle : — He first explained the nature, properties, and application of the pendulum, and made it perfect, except the compensation added by Graham, about 1700.

Anchor pallets were introduced by Clement, in 1680, who also devised the mode of suspending the pendulum from a stud, by means of a piece of watch-spring. The mechanism of repetition by means of pulling a string was invented by Barlow, 1676. The endless cord, to continue the clock in regular motion, during the time of winding up, was invented by Huyghens, 1660. This was otherwise effected by Harrison, 1735, by means of his auxiliary spring and additional ratchet. See Going-wheel. Huyghens was also the contriver of the present dial-work for changing the hour into sixty minutes which divide the circumference of the dial, traversed by an additional hand in the center of the clock-face.

Clocks were applied to purposes of astronomy as early as 1484. Gemma Trosius, in 1530, suggested their use at sea for acertaining the longitude. In 1741, the English government offered a reward of £20,000 for a correct mode of determining longitude at sea. This was won by Harrison, in 1762, who invented and introduced the compensating pendulum balance, made of two metals. See Balance ; Chronometer.

The balance-spring, which confers upon the balance the isochronal qualities of the pendulum, was invented by Hooke, who applied it in a straight form. Huyghens changed it to a helix.

Graham invented the dead-beat escapement in 1700. See Escapement.

The spring as a motor for time-pieces was invented by the Germans, and was rendered necessary to confer portability upon the invention. It was first placed on the arbor of the great wheel and a supplementary spring opposed the former during the first part of its unwinding. This was intended to counteract the inequality. The fusee was afterwards introduced. A watch with a fusee, made in 1525, by Lech, of Prague, was in London a few years back.

Musical or chiming clocks were invented in Germany. Burney notices them as early as 1580.

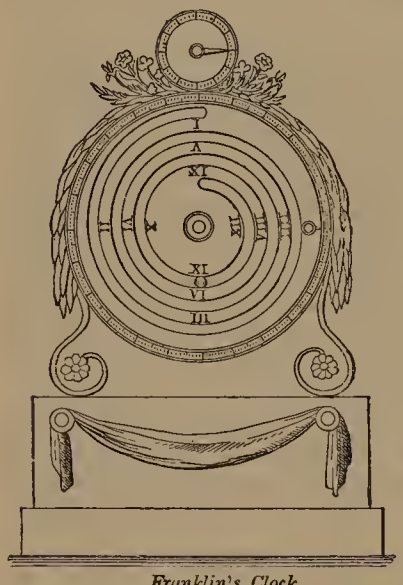
In 1544, the corporation of master clock-makers of Paris obtained a statute from Francis I., forbidding non-admitted persons to make *clocks*, *watches*, or *alarums*, large or small.

Benjamin Franklin's clock is noted as being the simplest on record. It shows the hours, minutes, and seconds, and yet contains but three wheels and two pinions in the whole movement. The lowest wheel has 160 teeth, and makes one revolution in four hours. It carries the hand on its axle, which points out both the hour and the minute. It turns a pinion of ten leaves, on the same axis with which

is a wheel of 120 teeth that gives motion to a pinion of eight leaves. The second-hand is attached to the axis of this latter pinion, as also the swing-wheel, which carries thirty teeth, that gives motion to the pallets of an anchor-escapement, and to its pendulum, that vibrates seconds.

The dial of this clock has an external circle having 240 divisions in four successive notations of sixty each. This circle shows the minutes ; within it the hours are arranged in a volute of three revolutions along four radii which form right angles with each other. By this arrangement, while the point of the hand shows the minute, the side shows the hour, or, more strictly speaking, that the hour is one of three at four hours' distance apart. It is supposed that there will be no mistake as to the reading, to the extent of four hours' difference. A small circle above the great one is divided into sixty parts for seconds.

Fig. 1331.



Franklin's Clock.

The clock is wound up by a line going over a pulley and ratchet on the axis of the great wheel.

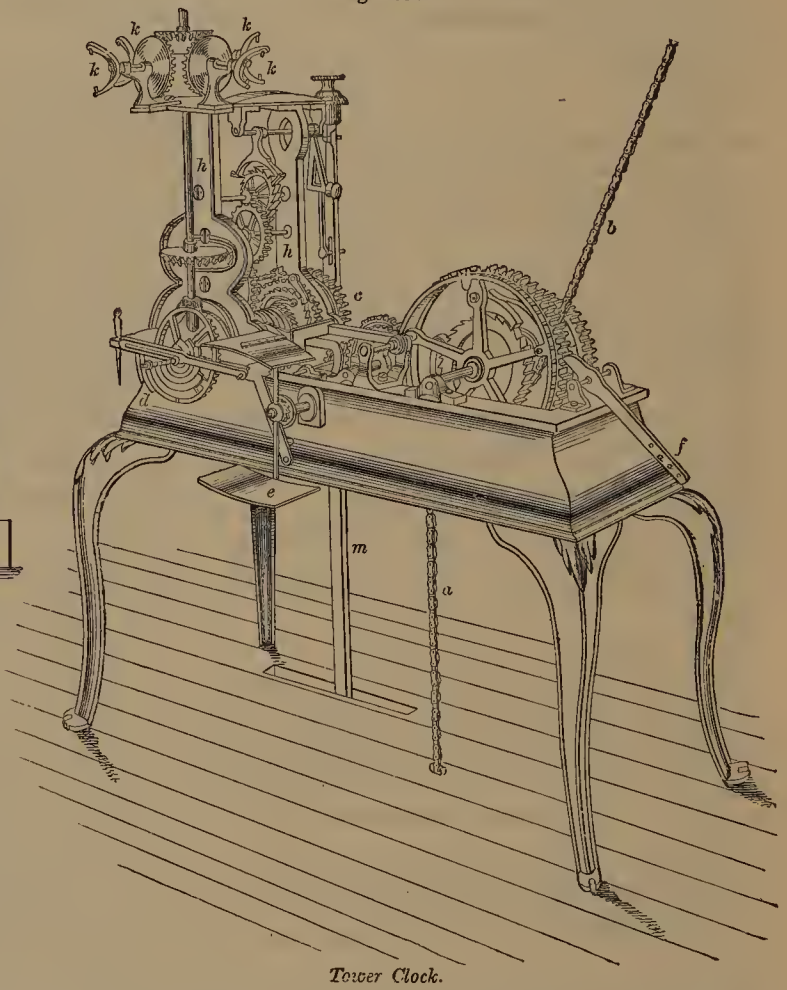
To remedy the imperfection in this clock, of the uncertainty of which hour of three it denotes, the spiral coil containing the hours has been changed to a groove of like form carrying a ball which constantly seeks the lowest position, and thus indicates the hour by proximity to the figures on the spiral.

Rev. John Wesley in his journal gives the following account of a talking clock : —

"On Monday, April 27, 1762, being at Lurgan, in Ireland, I embraced the opportunity which I had desired, of talking to Mr. Miller, the contriver of that statue which was in Lurgan when I was there before. It was the figure of an old man standing in a case, with a curtain drawn before him, over against a clock, which stood on the opposite side of the room. Every time the clock struck he opened the door with one hand, drew back the curtain with the other, turned his head as if looking round on the company, and then said, with a clear, loud, articulate voice, past one, or two, or three, and so on. But so many came to see this (the like of which all allowed was not to be seen in Europe), that Mr. Miller was in danger of being ruined, not having time to attend to his own business. So as none offered to purchase it or reward him for his pains, he took the whole machine to pieces."

Church clocks, or, as they are termed in the trade, *tower* clocks, are very diverse in their appearance from any hall or mantel clock. The clock in the illustration is supported by four legs upon the floor of the elevated apartment in the clock-tower, and is driven by two weights. *a* is the chain by which the *going* weight is suspended ; the chain *b* of the striking weight passes upward, over a pulley, and is thence suspended. Each chain, of course, keeps up a constant strain upon its own train, the *going* train affording through the escapement the urging pressure upon the pendulum-rod *m*, which keeps its motion even, and neutralizes exactly its tendency to beat gradually in a smaller and smaller arc, and eventually run down. The *striking* train keeps that portion of the machinery in constant readiness to respond whenever it is released by the recurrence of the completed hour. *c* is the *hour-wheel* and *d* the *snail*, the latter determining the number of blows, while the *fly e* regulates the rate of the striking, that is, the interval between the blows ; *f* is the *striking-lever*.

Fig. 1332.



Tower Clock.

The going train is principally between the standards *h h*, between which is seen the anchor of the escapement. The gimbals *k k k k* connect to as many rods, which drive the *motion-work* behind the

dials, situated in the four faces of the tower respectively.

The clock of Beauvais, France, is composed of fourteen different movements consisting of 90,000 pieces, weighing over 35,000 pounds, and costing £5,600. The body of the clock is 36 feet high, and 16 feet in breadth by nearly 9 in depth. The main dial — there are fifty in all — is the largest work in enamel in existence, and cost $650. Two hands of steel covered by platinum move over this dial through twenty-four divisions; it is pierced, as are all the others, and shows the pendulum, weighing nearly one cwt., which renews its impulse from a steel ball weighing a gramme, or about one thirty-second of an ounce. This movement impels the fourteen others, and is wound up weekly, being driven by weights in the usual way. The other dials are calendars of the days of the week and of the month, the month, year, zodiacal signs, eclipses, phases of the moon, etc. This clock shows seconds of time, and indicates events occurring not oftener than once in 100 years; for instance, it must be remembered that three centuries out of four the last year leaps its bissextile. In these years the clock has to leap from February 29, and goes from the 28th to the 1st of March. Here is a movement occurring only in 400 years.

A Strasbourger, jealous for the honor of his town-clock, seeks to outrank these Beauvais claims, and says: —

"Our cathedral clock shows all these indications and some besides. It contains an ecclesiastical computator with all its indications; the golden number, the epacts, dominical letter, solar cycle, etc.; a perpetual calendar with the movable feasts, a planetarium on the Copernican system, showing all the mean equinoctial revolutions of every planet visible to the naked eye; a celestial sphere showing the precession of the equinoxes, the solar and lunar questions for the reduction of the mean motion of the sun and moon to true time and place. The Beauvais clock makes a change in every fourth century; but ask an astronomer what is meant by the precession of the equinoxes. He will tell you it is a movement in the stars describing a complete revolution round the earth in the space of about 25,000 to 26,000 years. In the Strasbourg clock is a sphere following exactly this motion, and whose rotation is of that kind as to insure one revolution in 25,920 years. The thing can be measured and indicated; it is unnecessary to await its accomplishment."

The wooden-clock manufacture was commenced in Waterbury, Connecticut, by James Harrison, in 1790, on whose books the first is charged January 1, 1791, at £3 12s. 8d. In East Windsor the brass-clock manufacture was carried on by Daniel Burnap. In 1793, Eli Terry, who had been instructed in the business by Burnap, made brass and wooden clocks, with long pendulums; price for a wooden clock and case, from $18 to $48, the higher priced ones having a brass dial and dial for seconds, and the moon's age, and a more costly case. Brass clocks with a case cost from $38 to $60.

Terry used a hand-engine for cutting the teeth of the wheels and pinions, and a foot-lathe for the turned work. In November, 1797, he patented an improvement in clocks, watches, and time-pieces, covering a new construction of an equation clock, showing the difference between apparent and mean time. In 1802, in which year Willard of Boston took a patent for his time-pieces, Terry began the business on a larger scale by water power. In 1814 he introduced a new era in the business by commencing on the Naugatuck River the manufacture of the shelf or mantel clock, which he patented in 1816. The cheapness of these created a wide demand. Several improvements made by him in the mechanism, and the later progress in machinery generally, have increased the annual production in that State to hundreds of thousands, and given to every household a clock, equal to the old ones, at a cost of $2 and upward. His descendants have been engaged in the business to the present time, and his pupil, Chauncey Jerome, since 1821.

The Assembly of Connecticut, in October, 1783, awarded a patent for fourteen years to Benjamin Hanks, of Litchfield, for a self-winding clock. It was to wind itself by the help of the air, and to keep more regular time than other machines. The principle was made use of in New York and elsewhere.

Several ingenious applications of natural pulsations have been made to effect the same purpose: Washburn's Thermal-motor, for instance, in which the expansion and contraction of bars of metal is made by differential levers and ratchets to wind the spring.

Clocks with hands and dials having a common center are arranged to show the time at places having different longitudes. A number of concentric circles are marked upon the dial of a watch, each of which is marked with the name of a place. The several hands correspond to the number of circles, and are constructed of different lengths. The hands move upon a common center, but are capable of an adjustment, so that the distances between each of them may be made to correspond to the difference in time of the places marked on their respective circles.

An *astronomical* clock is one which has a compensating pendulum and otherwise of marked quality, used in determining time in observations.

A *chiming* clock is one in which the hours or fractions are marked by a carillon.

An *electric* clock is one whose movements are regulated by electro-magnetic devices.

A *regulator*, or watch-maker's clock of superior quality for regulating time-pieces.

A *sidereal* clock, one regulated to sidereal time, not mean time.

Clock-a-larm'. A device in a clock, which is capable of such arrangement that when a certain hour is reached a repetitive alarm shall be struck upon a bell.

An alarm arrangement was attached to the water-clock constructed in France, in the last century. The clock consists of a cylinder divided into several small cells and suspended by a thread fixed to its axis, in a frame on which the hour distances, formed by trial, are marked out. As the water flows from one cell to another, it changes very slowly the center of gravity of the cylinder, and puts it in motion. The alarm "consists of a bell and small wheels, like those of a clock that strikes the hours, screwed to the top of the frame in which the cylinder is suspended. The axis of the cylinder, at the hour when one is desirous of being wakened, pushes down a small crank, which, by letting fall a weight, puts the alarm in motion. A dial-plate with a handle is also placed within the frame."

Clock-move'ment Ham'mer. The striker of a clock which sounds the hours upon the bell or gong.

Clock-pil'lar. One of the posts which connect, and at the same time hold at the prescribed distance apart, the plates of a clock movement.

Clock-spring. A coiled steel spring in the going-barrel or the striking-barrel of a clock which

impels the train or strikes the hours, as the case may be. The steel ribbon from which the springs are made is about 3 inches wide, and is split by circular shears into widths $1\frac{1}{2}$ inches to $\frac{3}{10}$ of an inch, for the different powers required. Pieces of the same breadth are riveted together at the ends to make them continuous, are coiled on a reel, from which they pass to be hardened, tempered, polished, and colored. The heating is done by passing the steel ribbon through a red-hot iron tube 6 feet long, 6 inches wide, and 2 inches deep, which is laid lengthways of a furnace of suitable length, so that, while the ribbon is heated by the red-hot tube, it will not come in contact with the fuel. As the ribbon emerges from the hot tube, it passes into a bath of oil in a tank six feet long and kept cool by a water-jacket through which a stream constantly passes. It then passes through a bath of molten lead, which gives it the necessary temper; then between iron rollers, which are the medium of determining the rate of motion of the ribbon through the heating-tube, the hardening-bath, and the tempering-bath. The rate of progression is about 1,000 feet per day, and of narrower ribbons several may be passed at a time. From the rolls the ribbons are again wound over reels and taken to be polished and colored. The ribbon is then passed over and under leather-covered wooden rollers revolving in boxes of emery, by which both surfaces of the steel are polished; at the same time two vulcanite wheels smooth and round the edges. It is then passed through a bath of molten lead, which gives it its color; after cooling it is cut into lengths, the ends softened, the hooks and eyes put on, and the springs coiled up and packed for sale.

Clock-watch. A watch adapted to strike the hours and quarters similarly to a clock, as distinguished from a *repeater*, which strikes the time only when urged to do so,— by pushing in the stem, for instance.

Clock-work Lamp. Carcel's clock-work lamp pumps up oil from the reservoir in the foot of the lamp and overflows back again from the burner to the reservoir, the flow being in excess of the consumption so as to prevent the heating of the metallic portions around the wick. The clock-work is run by a spring or a descending weight, according to circumstances of size, position, purpose, or requirements of portability. In lighthouses, the excessive supply inducing overflow is a necessary feature, to secure uniform supply, and the arrangement differs from the domestic form of lamp.

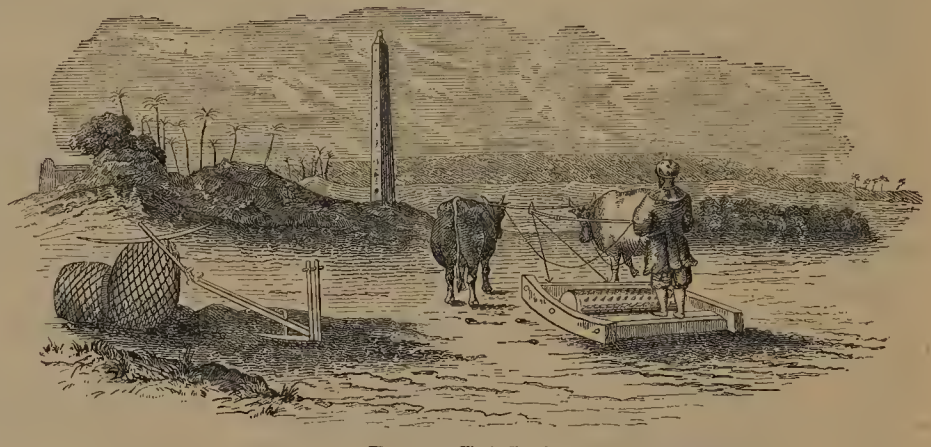
De Kerevenan's clock-work lamp has a fan driven by clock-work in the stem or foot, furnishing a blast of air on each side of a flat wick to urge the flame and perfect the combustion of the carbon of the oil. This may be or has been applied to Argand lamps.

Clock-work has been applied to lamps and to gas-burners to light them at a specific prearranged time, the device being on the principle of the alarm clock and operating upon a lever or trigger to light a match, close an electric circuit, or by other means.

Clod-crush'er. The modern Egyptians use a machine called *khonfud*, *hedgehog*, to break the clods, after the land has been plowed. It consists of a cylinder, studded with projecting iron pins. The land shown in the cut is in the vicinity of the ancient Heliopolis, and within sight of the minarets of Cairo.

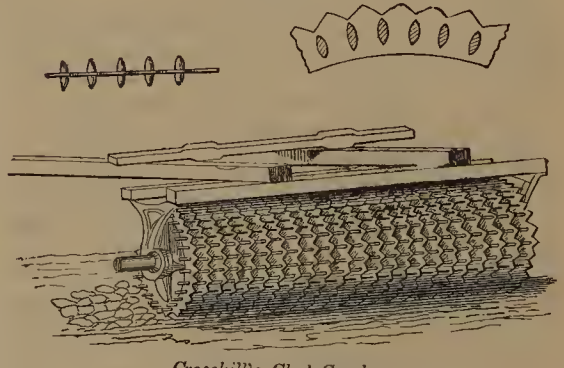
One form of clod-crusher consists of a series of cast-metal rings, or roller-parts, placed loosely upon a round axle, and revolving thereon independently of each other, so as to produce a self-cleaning action, and enable the machine to be readily turned round about. The surfaces of the roller-parts are pointed with serrated edges and a series of inner teeth, projecting sideways, fixed at a particular angle to the center of the roller-axle, so as to act most effectually in penetrating clods perpendicularly, and in consolidating the young plants in the soil. The roller is removed from place to place on two traveling wheels of larger diameter, which lift the roller-parts clear off the ground. When the roller has arrived in the field where it is intended to be used, the wheels are removed.

Fig. 1333.



Egyptian Clod-Crusher (from Wilkinson).

Fig. 1334.

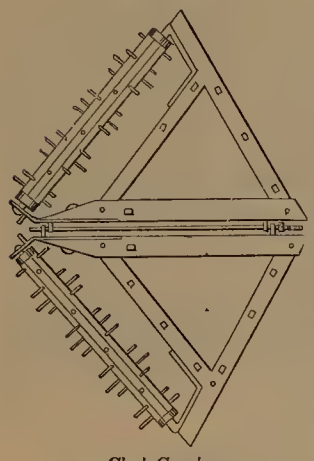


Crosskill's Clod-Crusher.

Another form of clod-crusher has spiked rollers attached in the rear of a harrow.

Clog. A protection for the foot worn over the shoe. The sole is elastic, being made of leather or else having a hinge in the shank. A toe-cap, heel-piece, and instep-strap hold it on the foot. Beneath the sole-piece are an extra sole and heel-tap, made of wood.

Fig. 1335.

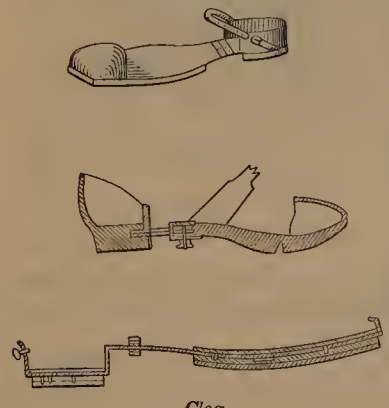


Clod-Crusher.

It is yet much used in Europe, but goloshes or india-rubber overshoes have to a considerable extent superseded the clog.

The clog is an ancient form of foot-wear, and consisted of a leathern upper and wooden sole; the upper was nailed to the edge of the sole; the latter was sometimes an inch thick, and often hooped with sheet-iron. They were worn by the Grecks and Romans, and are still common in Italy, Spain, and Portugal. They are known as *sabots* in France; *galochas*, *tamancos*, and *zuecos* in other parts of the Continent of Europe.

Fig. 1336.



Clog.

The Sabotiers, an order of friars which originated in the fourteenth century, vowed to "be shod with wooden shoes," probably as an improvement on the barefooted Carmelites. They were formerly worn by kings, came to be regarded by the populace of England as representing Popery and slavery, and formed the burden of popular outcry, aiding in the expulsion of James II. from the country. The cry of the mob, "No slavery, no wooden shoes," made Walpole's life uneasy.

Clois'ter. (*Architecture.*) A covered ambulatory.

Close-butt. (*Shipbuilding.*) A fayed or rabbeted joint where the parts are so closely fitted or driven as to dispense with calking.

Clos'er. (*Masonry.*) *a*. The last stone or brick in a horizontal course closing the gap.

b. A brickbat inserted in course when the gap will not admit a whole brick.

A *king closer* is a bat, three quarters the size of a brick. A *queen closer* is a quarter-brick.

Close-stool. A commode or box with tightly fitting lid to contain a chamber-vessel. A *chamber-stool*.

Close-wall. (*Building.*) An enclosing wall.

Clos'ing-ham'mer. A hammer used by boiler-makers and iron ship-builders for closing the seams of iron plates. See RIVETING-TOOLS.

Cloth. (*Fabric.*) A woven fabric of cotton, linen, or wool. Silk perhaps hardly comes within the category. See FABRIC for list of woven goods.

Woolen cloth, after weaving, is subjected to the following processes: —

Braying or *scouring:* that is, washing in troughs with heavy mallets, water and detergents being used to remove the oil and all acquired filth.

Burling: picking off the knots made by the weaver.

Milling or *fulling:* to felt the fibers of the cloth closer together, increasing the compactness of the fabric and the finish of the face. See FULLING-MILL.

Dressing: this is done by teasels, whose hooked ends bring the loose fibers to the surface to form a nap. See TEASELING; DRESSING.

Shearing: the filaments drawn out by the teasels are shorn or singed to a length. See CLOTH-SHEARING MACHINE.

Pressing: the cloth is arranged in regular folds and subjected to hydrostatic pressure. A polished pressing-board is placed between each fold. See CLOTH-PRESS.

Some of the later processes of the cloth-manufacture are varied or combined.

Hot-pressing, *boiling*, *steaming*, are each of them means for giving a fine finish by the application of heat.

Picking is a process of removing blemishes by tweezers, or coloring faulty spots by a hair-pencil and dye.

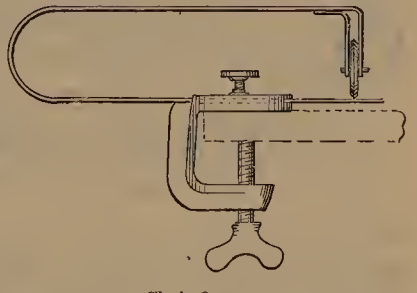
Fine-drawing is closing minute holes or faults in the fabric, by inserting sound yarns by means of a needle.

Marking consists in working-in with white or yellow silk a word or mark indicating the quality of the piece.

Baling and *packing* conclude the series of processes.

Cloth-creas'er. A device which may be clamped to the table or the sewing-machine, the crease being made by the adjustable bevel-edged wheel under which the fabric is drawn.

Fig. 1337.



Cloth-Creaser.

Cloth-cut'ting Ma-chine'. A machine for cutting cloth into strips, or into shapes for making into garments.

Among the various forms and modes may be cited: —

Knives corresponding in shape to the various parts of a garment are mounted upon a reciprocating platen, and descend upon the material piled in thicknesses upon the bed beneath. Envelope blanks are cut out of the sheet in this manner.

A guillotine knife, straight or curved, and descending vertically.

A knife or saw reciprocating vertically in a constant path like a scroll saw, while the pile of cloth below is moved beneath so that the saw or knife follows a line marked upon the upper layer of cloth. The knife is reciprocated like the needle of a sewing-machine, and a presser foot holds the material. It has also an intermittent feed.

A band-saw acting in the same manner.

A rotary cutter mounted on a vertical spindle which allows the edge of the knife to be presented in any direction.

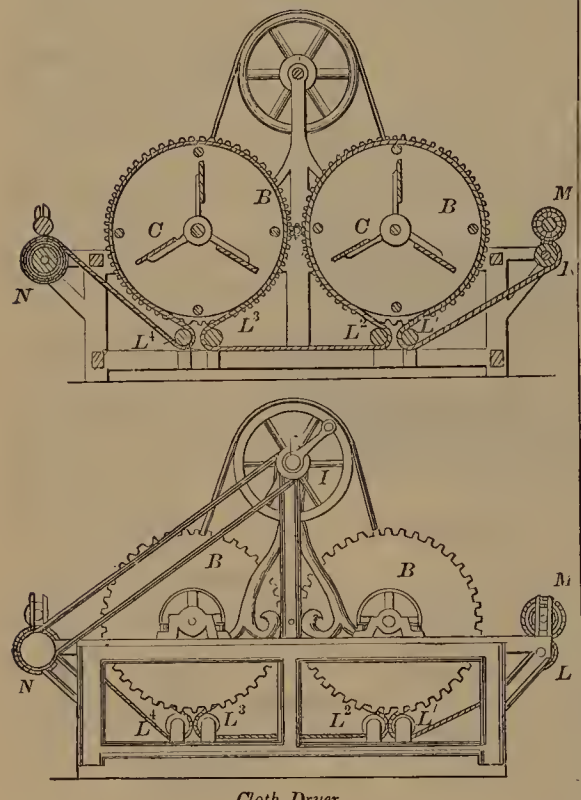
A mandrel with rotary cutters to cut cloth into strips for carpet or for other purposes.

Cloth-dress'ing Ma-chine'. A machine in

which the nap of woolen cloth is raised by teasels. See TEASELING-MACHINE. Also known as a *gigging-machine.*

Cloth-dry'ing Ma-chine'. A machine with heated rollers over which cloth is passed to drive off the moisture acquired in dyeing, washing, etc. In the example, *M* is the feed-roll from which the cloth unwinds; it thence passes over the cylinder *B B*, against whose surface it is tightly drawn by

Fig. 1338.



Cloth-Dryer.

the guide-rollers L^1 L^2 L^3 L^4, while the fans *C* drive a current of air through the meshes of the wire-gauze cylinders and the cloth. *N* is the take-up roller on which the cloth rewinds.

A steam cloth-dryer shown at the Paris Exposition had an annular steam-chamber constructed of two concentric cylinders, which formed a closed cavity, and constituted the circumference of a wheel more than 12 feet in diameter. Around the circumference of this wheel, which turned slowly upon a horizontal axis, the cloth was carried, being kept in position by means of two endless chains having tenter-hooks attached. The cloth passed round nearly the entire circumference, being carried off on the same side at which it was introduced; the velocity of motion at the circumference was about six inches per second.

The construction permits the steam-chamber to be made very secure against accident, and yet to present an exterior of quite thin metal, facilitating greatly the transmission of heat. The necessary strength is obtained by means of numerous interior stays connecting the two cylindrical surfaces. The steam is admitted through the axis.

Cloth Em-boss'ing. This is performed in a rolling-press, the engraved cylinders of which act upon the fabric (or paper), which is passed continuously between them; or one or more of the cylinders may be printing-cylinders having the usual color-vats and doctors.

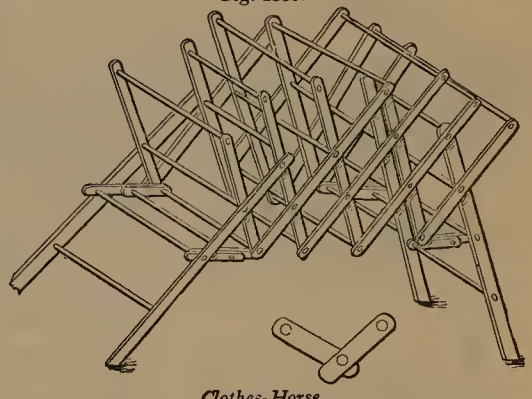
Clothes-brush. A brush usually having good black Russian bristles, adapted for brushing cloth.

Clothes-dry'er. A frame on which clothes are suspended to dry. Among the multitude of forms may be mentioned the post with extensible bars and parallel cords, Fig. 1339; this may be dismounted and collapsed like an umbrella. The toggle-jointed frame, with cross-rounds like a ladder, and folding up on the lazy-tongs principle. Others are clothes-horses, consisting of frames with cross-bars, and shutting together like book-covers. Another form has radial bars like spokes, or a slatted frame hinged like a trap door, etc., etc.

The centrifugal machine is used to remove all the moisture that can be got rid of by mechanical means.

Clothes-horse. A form of clothes-dryer which stands on legs and has cross-bars on which clothes

Fig. 1339.



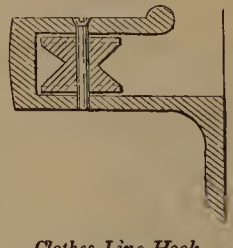
Clothes-Horse.

may be suspended to dry. The figure shows numerous rounds on a frame collapsable on the lazy-tongs principle.

Clothes-line. A cord or wire for suspension between posts or other supports. It is preferably of white cord, and wound on a reel in the intervals of non-use. If left exposed tinned iron wire is good.

Clothes-line Hook. A hold-fast or bracket, with a spool on which the line runs and is stretched.

Fig. 1340.



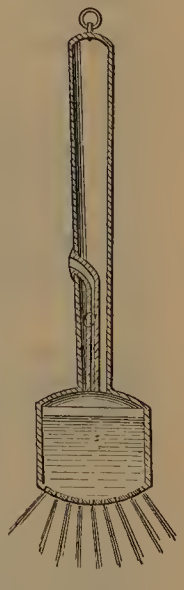
Clothes-Line Hook.

Clothes-line Reel. A cylinder or axle, on which a clothes-line is wound and usually journaled in a protected bracket or under a pent-roof secured against a building or tree.

Clothes-pin. A little spring nippers which pinches a garment against the line from which it is suspended to dry. It may be a split pin; a pair of hinged fingers with a spring enclosed; a bent wire having a bight which yields and clasps, etc.

Clothes-pins are turned and slotted in machines specially constructed therefor.

Fig. 1341.



Clothes-Sprinkler.

Clothes-press. 1. A receptacle for clothes. A closet.

2. A press in which clothes are flattened and creased; crape shawls, for instance. See CLOTH-PRESS.

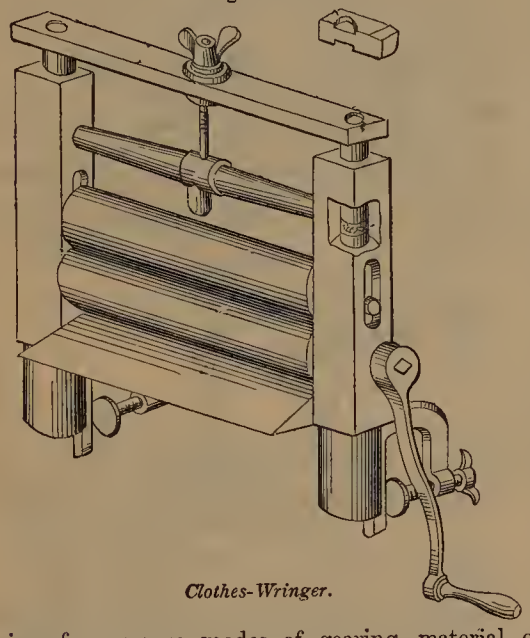
Clothes-sprink'ler. A receptacle for water, with perforations through which a fine shower of water is thrown upon clothes in damping them previous to ironing.

Clothes-stick. A rod by which clothes are turned, loosened, or lifted, while in the wash-boiler.

Clothes-tongs. A grasping-tool for removing hot clothes from a boiler, in washing or dyeing.

Clothes-wring'er. A frame having a pair of elastic rolls, through which clothes are passed to squeeze out the water. The improvement concerns

Fig. 1342.



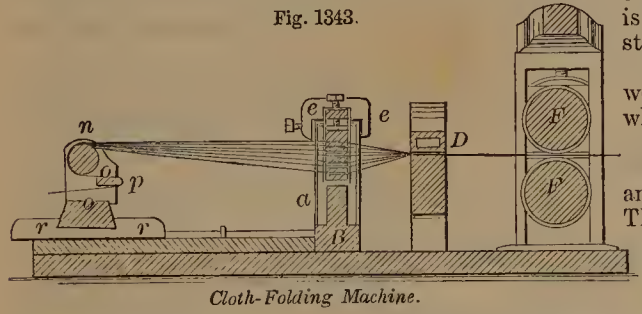
Clothes-Wringer.

springs for pressure, modes of gearing, material of rollers and modes of securing them to their shafts, modes of securing the wringer to the side of the tub. See WRINGER.

Cloth-fin'ish-ing Ma-chine'. One for *teaseling* and *shearing;* raising the nap, and bringing it to an even length. See TEASELING; SHEARING; NAPPING.

Cloth-fold'ing Ma-chine'. One in which wide goods are folded lengthwise, ironed and pressed ready for baling. In the example the cloth is passed over the bulging, spreading roller *n*, which is adjustable, and between the folders, which consist

Fig. 1343.



Cloth-Folding Machine.

of a plate bent into a sinuous form like a flattened **S**. From the folders the cloth passes beneath the inclined steam-heated ironer *D*, and from that to the rollers *F F*, by which it is drawn forward.

Cloth'ing 1. (*Steam.*) An outside covering of felt, or other non-conducting material, on the outside of a boiler or steam-chamber to prevent radiation of heat. *Cleading; lagging.*

2. (*Carding-machine.*) Bands of leather studded with teeth of wire which engage the fiber. See CARDING-MACHINE.

The following names of parts of clothing are used in a mechanical sense: —

Band.	Hoop.
Belt.	Jacket.
Bonnet.	Lining.
Boot.	Pocket.
Breeching.	Seam.
Button.	Shoe.
Cap.	Skirt.
Collar.	Sleeve.
Cuff.	Sole.
Hat.	Yoke.
Hood.	

3. (*Menage.*) Full horse-clothing consists of the quarter-sheet, breast-piece, hunting-piece, pad-cloth, hood, body-roller, and knee-caps.

Cloth-meas'ur-ing Ma-chine'. A machine by which fabrics made in great lengths are measured off in pieces of convenient length for sale, and hence known as piece-goods.

Cloth-pa'per. Heavy paper used between folds of cloth, in the finishing-press.

Cloth-plate. That plate in a sewing-machine on which the work rests, through which the needle passes, and beneath which is the looper, or the lower spool or shuttle, as the case may be.

Cloth-press. A hydrostatic press in which woolen cloths are subjected to pressure.

The cloth is arranged in regular folds, a polished pressing-board being arranged between each fold to prevent contact of the cloth surfaces with each other. Between each two pieces of cloth is an iron plate.

For *hot-pressing*, three hot iron plates are inserted between the folds at intervals of about twenty yards. Cold iron plates next to the hot ones moderate the heat. Pressure is then applied, and the pile allowed to stand till cold. The cloth is then taken and repiled, so that the creases of the former piling come in the middle of the pressing-boards at the second pressure. Hot pressing gives a lustrous appearance, but is apt to spot with rain.

Boiling and *steaming* have been substituted for hot-pressing, or used in connection therewith.

In the former the cloth is wound tightly upon a wooden or iron roller, immersed in water heated to 180° F., steeped for five hours, taken out and cooled for twenty-four hours. It is treated in this way four or five times; is washed with fuller's earth. It is then stretched on a tenter-frame and dried in a steam-heated room.

In *steaming*, after the cloth is *hot pressed*, it is wound around a perforated copper roller, into which steam is then admitted. If at high pressure, it will pass through all the folds in a few minutes; if at low pressure, it will require one and a half hours. After this it is boiled twice. This steaming saves the time of three boilings.

Cloth-prov'er. A magnifying-glass employed in numbering the threads in a given space of cloth.

Cloth-shear'ing Ma-chine'. A machine for cutting to an even length the filaments of wool drawn out in the process of *teaseling*. It was formerly done by hand.

One cloth-shearing machine consists of a fixed

semicircular rack concentric with a cutting-edge called a *ledger-blade*, and a large revolving wheel containing eight small cutting-disks, whose shafts have pinions which engage with the teeth of the semicircular rack, so as to give the cutting-disks a rotary motion on their axes, in addition to their revolving motion with the large wheel. The machine travels over the cloth, or the cloth under the machine, as may be arranged.

Revolving shears are used for shearing off the loose fibers from the face of woolen cloths. For narrow cloths the cylinders are 30 inches long and 2 in diameter; 8 thin knives are twisted around the cylinder, making 2¼ turns in the length, and are secured by screws and nuts which pass through flanges at the end of the axis. Formerly the cylinders were grooved and fitted with thin, narrow plates of steel 6 or 8 inches long. The edges of the 8 blades are ground, so as to constitute parts of a cylinder, by a grinder or strickle fed with emery, passed to and fro on a slide parallel with the axis of the cylinder, which is driven at about 1,200 turns in the minute.

In use, the cylinder revolves at about the same rate, and in contact with the edge of a long, thin plate of steel, called the ledger-blade, which has a very keen rectilinear edge, whetted to an angle of about 45°; the blade is fixed as a tangent to the cylinder, and the two are mounted on a swing-carriage with two handles, so as to be brought down by the hands to a fixed stop. The edge of the ledger-blade is sharpened by grinding it against the cylinder itself, with flour, emery, and oil, by which the two are sure to agree throughout their whole length.

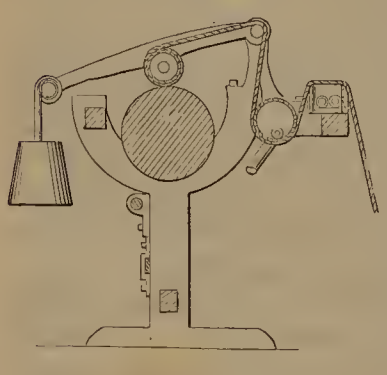
The cloth, before it goes through the process of cutting, is brushed, so as to raise the fibers; it then passes from a roller over a round bar, and comes in contact with the spring-bed, which is a long elastic plate of steel, fixed to the framing of the machine, and nearly as a tangent to the cylinder; this brings the fibers of cloth within the range of the cutting-edges, which reduce them very exactly to one level.

This machine has several adjustments for determining with great nicety the relative position of the ledger-blade, cylinder, and spring-bed.

Formerly the cloth was passed over a fixed bed having a moderately sharp, angular ridge; but this was found to cause holes in the cloth.

Broadcloths require cylinders sixty-five inches long, and machinery of proportionately greater strength. In Lewis's patent cloth-cutting machine (English) the cloth is cut from *list* to *list*, or transversely, in which case the cloth is stretched by hooks at the two edges, and there are two spring-beds; the cylinder in this machine is forty inches long, and the cloth is shifted that distance between each trip, until the whole piece is sheared.

Fig. 1344



Cloth-Smoothing Machine.

Other fabrics, such as carpets, are sheared by the same description of machine.

The lawn-mower operates on the same principle.

Cloth-smooth'ing Ma-chine'. A smoothing and ironing device for cloth in the piece. The cloth is damped and heated by passage over a trough inclosing a perforated steam-pipe, and then beneath a hollow heated cylinder. The winding roller is journaled in a weighted frame, and the cloth is wound while under pressure between the said roller and the main cylinder.

Cloth-spong'er. A device for damping cloth previous to ironing. In machines for this purpose the cloth is sponged by steam applied through a perforated adjustable horizontal cylinder around which it is rolled.

Cloth-stretch'er. A machine in which cloth is drawn through a series of frictional stretching-bars and passed over spreading rollers so as to equalize the inequalities on its surface and enable it to be firmly and smoothly wound on the winding-roll.

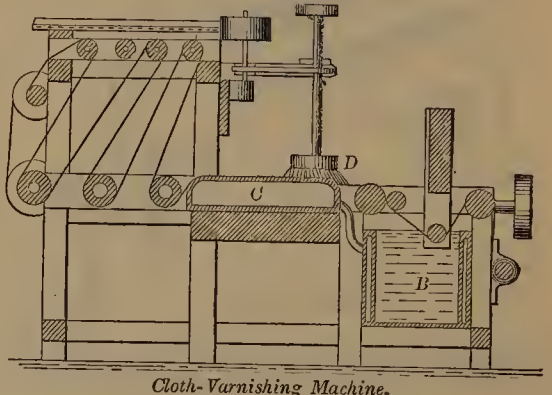
Cloth-tear'ing Ma-chine'. A machine having a fluted roller and knife-edges. The latter push the cloth into the flutes and tear it into strips as it passes through the machine.

Cloth-teaz'ler. A machine for raising the nap of cloth. See TEASELING-MACHINE.

Cloth-var'nish-ing Ma-chine'. For making the enameled or varnished fabric.

The cloth is passed from the let-off roller beneath a roller in the steam-heated size-vat *B*; thence to a steam-heated table *C*, where the varnish is spread

Fig. 1345.



Cloth-Varnishing Machine.

by a revolving brush *D*, and thence over the rollers of the drying-frame, where it is exposed to jets of air from a perforated pipe, and from which it is wound on a take-up roller.

Cloth-wheel. 1. A grinding or polishing wheel, covered with cloth charged with an abrading or polishing material; as, *pumice-stone*, *chalk*, *rotten-stone*, *crocus*, *putty-powder*, *rouge*, etc.

The cloth used is heavy, similar to that used for the blankets of printing-presses. Felted cloths are sometimes used.

The cloth-wheel is used by opticians, lapidaries, and ivory-workers.

2. A form of feed-movement in sewing-machines. A serrated-faced wheel protrudes upwardly through the cloth-plate, and has an intermittent motion.

Cloud'ing. 1. An appearance given to silks and ribbons in the process of dyeing.

2. A diversity of colors in a yarn recurring at regular intervals.

Clough A sluice used in returning water to a channel after depositing its sediment on the flooded land.

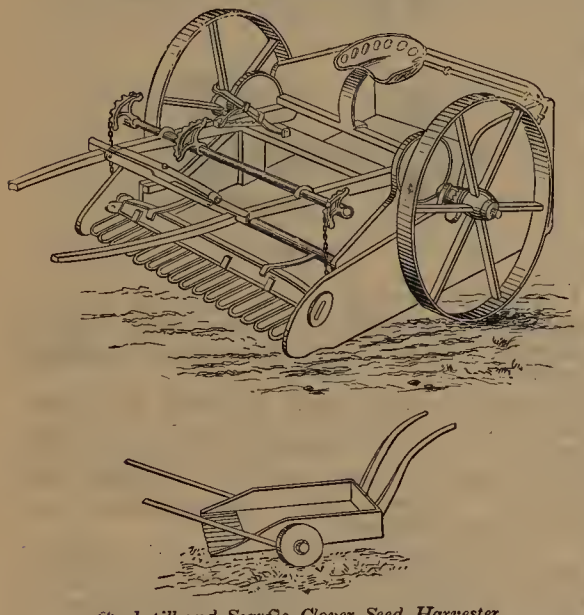
A *floating clough* is used for scouring out some of the channels of the Humber. It consists of a frame covered with plank, and having a central culvert and sluice. In front are timbers shod with iron in serrated form, which can be raised or lowered at

pleasure. Side wings are sloped to accommodate themselves to the inclination of the banks. When the water is at high tide the clough is floated up stream and sunk in the channel by admitting water; and the wings extended by ropes. At full ebb the serrated frames are let down, the machine allowed to yield to the body of water above, which forces it along, the teeth scraping up the mud, and the current carrying it off.

Clout. (*Carriage.*) An iron shield or plate placed on a piece of timber in a carriage — as on an axle-tree — to take the rubbing and keep the wood from being worn.

Clout-nail. *a.* One with a large flat head.

Fig. 1346.



Stockstill and Scarf's Clover-Seed Harvester.

Such are used to stud timbers exposed to the action of marine borers; also in fastening leather to wood.

b. A long blunt stub-nail for boot-soles.

c. A flat-headed nail, used for securing *clouts* on axle-trees or elsewhere.

Clove. (*Fr. Clou.*) A long spike-nail.

Clove-hitch. (*Nautical.*) Two half-hitches. A half-hitch is to give the rope a turn around the object, pass the end of the rope round its standing-part, and then through the bight. To make a *clove-hitch*, repeat the motion around the standing part and through the bight, and stop the end to the standing-part. See HITCH.

Clove-hook. (*Nautical.*) An iron two-part hook, the jaws overlapping; used in bending chain sheets to the clews of sails, etc.

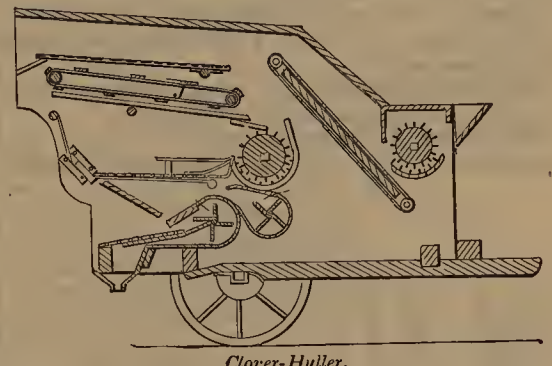
Clo'ver-seed Har'vest-er. Fig. 1346 illustrates one mode of harvesting clover-seed, and resembles the first of which we have any record. A wheat-harvester on this principle was running in Gaul, in the first century of the Christian era, and the machine continued in favor for 300 years, although it does not appear to have been used in Italy. In front of the machine is a row of fingers, between which the stalks of the clover pass, while the heads remaining above are torn off and are scraped into the box of the machine. It is known as a *header*.

In the old machine used 1,800 years ago in Gaul, it was the duty of the attendant to sweep the ears back into the box of the machine, which was driven before the ox that impelled it.

The English clover-harvester of thirty years back, shown in the lower part of same figure, is of the old Gallic pattern, is drawn by one horse, and guided by handles in the rear. The load is scooped out occasionally and deposited in bunches in the field.

Clo'ver-hull'er. Red clover (known in England as "broad clover") came from Flanders to England

Fig. 1347.

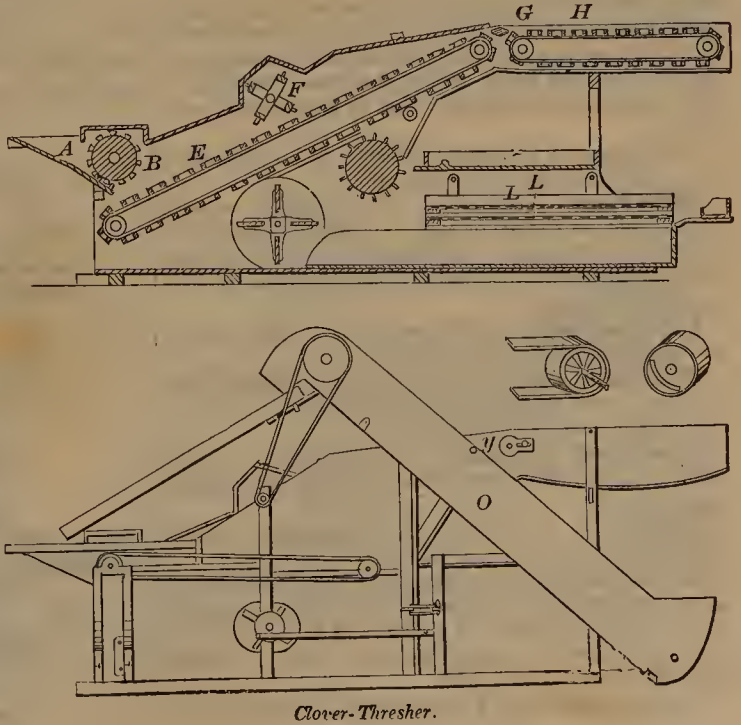


Clover-Huller.

and from England to the United States. Its adoption was strongly urged by Sir Richard Weston, in 1645, who saw it growing near Antwerp in 1644, and noticed the speed of its growth and how soon it recovered after mowing. In ten years it had spread through the kingdom and made its way to Ireland.

The clover-heads, previously separated from the straw by tramping or thrashing, after passing beneath the thrashing-cylinder, are raised by an endless carrier to a riddle, through which the seed falls upon a carrier which takes it back to the huller, by which

Fig. 1348.



Clover-Thresher.

the seed is liberated from the hulls, to be separated by the fans and riddles.

Clo'ver-thrash'er. A machine in which clover, hay, or the aftermath, which is cut for the seed alone, is thrashed and the seed hulled and cleaned.

The clover is fed in at the throat *A*, thrashed by the cylinder *B*, received on the slatted apron *E*, carried up past the beater *F*, the hay picked off by the picker *G*, and removed by the straw-carrier *H*, while the seed and chaff fall into the shaking-shoe, where the sieves *L*, the vibratory action, and the blast finish the separation and deliver the results separately.

The lower figure shows the outside of the machine, the arrangement of the belting, and the elevator-box *O*, in which the tailings and unhulled heads are carried up to be rethrashed.

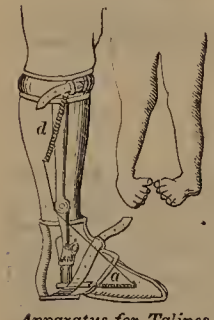
Clow. A sluice with a sliding-gate. See CLOUGH.

Club'bing. (*Nautical.*) Drifting down a current with an anchor out.

Club-com'pass-es. A pair of compasses with a bullet or cone on one leg to set in a hole.

Club-foot, Ap'pa-ra'tus for. Sheldrake's apparatus for club-feet and other deformities (English patent, 1801) proceeds upon the principle of continued, repeated, and varied application of springs to correct the abnormal deflection of the part.

Fig. 1349.



Apparatus for Talipes Varus.

Tiemann's apparatus for *talipes varus* has a strong leather shoe with a metallic sole and a joint near the heel to allow lateral motion. A spiral spring draws the foot outward by a constant, elastic, and easy traction. This pressure is increased or decreased at will, by fastening the spring in a series of sockets.

The single outside upright steel bar with joints at the ankle is fastened round the limb below the knee-joint, and so constructed that the screw at the ankle-joint forces the foot flat upon the floor, which foot in almost all cases is turned under as indicated by the sketch. The spiral spring *d* being attached to a cat-gut cord, passing round a pulley at the center of the bar and fastened near the toes upon the outside of the foot, elevates the toes and stretches the tendo Achillis, at the same time drawing the foot to its natural position.

The apparatus for *talipes valgus* is on the same principle, but with reversed action.

Club-haul. (*Nautical.*) To bring a vessel's head round on the other tack, by letting go the lee anchor, and cutting or slipping the cable, the sails being handled so as to cast the vessel's head in the required direction.

Clump-block. (*Nautical.*) One made thicker and stronger than ordinary blocks.

Clus'tered Arch. (*Architecture.*) Arched ribs of which several spring from one buttress; shown in the Gothic order of architecture.

Clus'tered Col'umn. (*Architecture.*) A pier which consists of several columns or shafts clustered together.

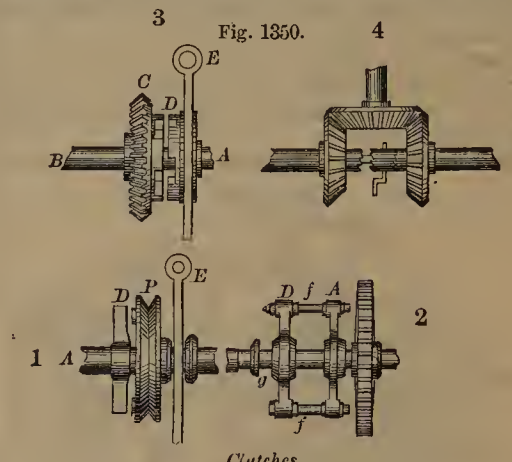
Clutch. 1. (*Machinery.*) A coupling for shafting used in transmitting motion.

The common clutch or gland 1 (Fig. 1350) has a loose band-pulley *P*, which revolves freely upon the shaft *A* except when it is shifted by the lever *E*, so that its projections engage with the gland *D*, which is firmly keyed to the shaft.

The bayonet-clutch 2 has *bayonets f f* attached to a sliding arm *D*, and which slip through holes in the cross-head, which is keyed on its shaft. *D* is secured by a feather on its shaft, and *g* is the seat for the shifting lever.

In 3, the clutch-box *D* is socketed upon the square arbor of the shaft *A*, and may be slipped by the lever *E* either towards or from the counterpart

Fig. 1350.



Clutches.

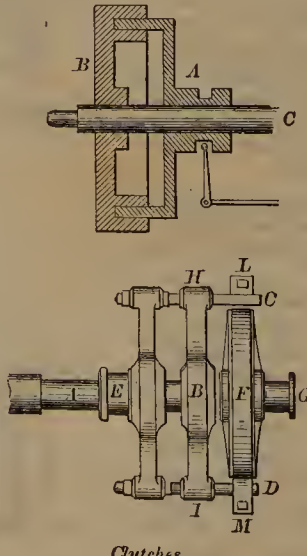
box, which is attached to the constantly revolving cog-wheel *C* and shaft *B*. The faces of the coupling-members have coacting projections and interdental spaces.

4 shows a double-clutch by which the vertical shaft is made to drive the lower one in either direction. The lower shifting-piece is secured by a feather upon the shaft, and may be coupled with either of the bevel-wheels, which otherwise run looscly upon the shaft.

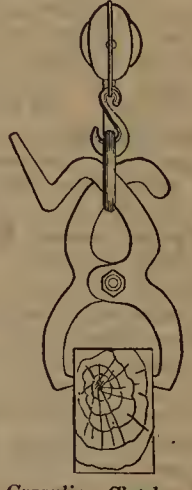
The *cone*-clutch consists of a tapered cylindrical plug sliding on a fast feather in one shaft, and admitting of being forced by a suitable arrangement of levers into the interior of a somewhat similar cylinder fixed on the shaft to be driven.

The *disk*-clutch is another form of friction-clutch, one disk *A* being slipped upon a spline on the shaft *C* so as to impinge upon a rotating disk *B*, and partake of its motion or impart motion thereto by frictional adherence. Friction-clutches are used in heavy machinery so as to start the machines without a sudden jar.

Fig. 1351.



Clutches



Grappling-Clutch.

The lower illustration shows another form of friction-clutch in which a hoop *F* on the shaft *G* is set in motion by the bayonet *C D E*, which is slipped upon the shaft *A*, the rods *C D* sliding in holes in the cross-head *H B I*, which is keyed fast to shaft *A*. When the bayonets project, as in the illustration, they come in contact with the studs *L M* on the hoop, and impart motion thereto. The hoop may be tightened on the wheel, which it incloses to just such an extent as will cause it to impart motion thereto, when revolved, without giving too sudden a jerk in starting.

2. *a.* A gripper in the end of a chain by which it is connected to the object to be moved, as in the foundry-crane, whose clutches take hold of two gudgeons in the centers of the ends of the flask, so that a mold can be lifted and turned round in the slings for examination, repair, transposition, or removal.

b. A gripper having teeth which clasp a joist or rafter of a barn to afford a means for suspending tackle for lifting in hay, ice, or what not.

Clys'ter-pipe. The nozzle of an enema syringe.

Clys'ter-syr'inge. A syringe for administering medicines per ano. See ENEMA-SYRINGE.

Coach. 1. (*Vehicle.*) A four-wheeled close carriage with two seats inside, and an outside driver's seat.

The term is found in some form or other in almost all the languages of Europe, and is closely allied to *couch;* reclining in comfort seems to be at the bottom of it. So Mary, Infanta of Spain, wife

Fig. 1352.

Queen Elizabeth's State Coach.

of the Emperor Ferdinand III., thought, as she rode in Carinthia in a close carriage with glass windows. Queen Elizabeth's carriage was rather more solid than graceful.

Hackney - coach ; a coach kept for hire.

Stage - coach ; one travelling on a regular route, and carrying passengers. The style varies in diferent countries. The stage in England carried six inside and fourteen outside, besides the driver and guard.

Mail - coach ; one employed in carrying the mails and passengers. See CARRIAGE ; CART ; CHARIOT.

2. (*Nautical.*) A cabin on the after-part of the quarter-deck. A round-house.

Coak. 1. (*Carpentry.*) *a.* A projection from the general face of a scarfed timber, of the nature of a tenon, and occupying a recess or mortise in the counterpart face of the other timber. A tabling. The mortise is sometimes known as a *sunk-coak.*

b. A joggle or dowel by which pieces are united to prevent slipping past each other, or to fasten them together. See DOWEL.

2. A square bushing in the sheave of a block, which forms a socket for the pin. See BLOCK.

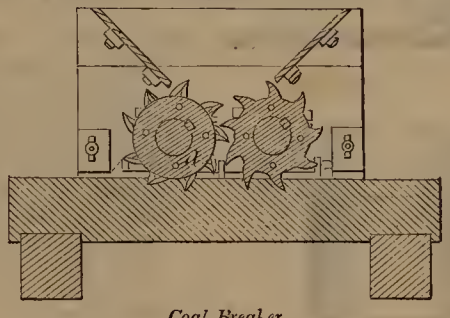
Coal-bor'ing bit. A bit with an entering point and a series of cutting edges of steps of increasing radius.

Coal-break'er. A machine for crushing lump-coal as taken from the mine. Also adapted to cleanse and assort it.

The principle is illustrated in the annexed cut ; rollers with spikes.

The new breaker erected near Carbondale by the

Fig. 1353.

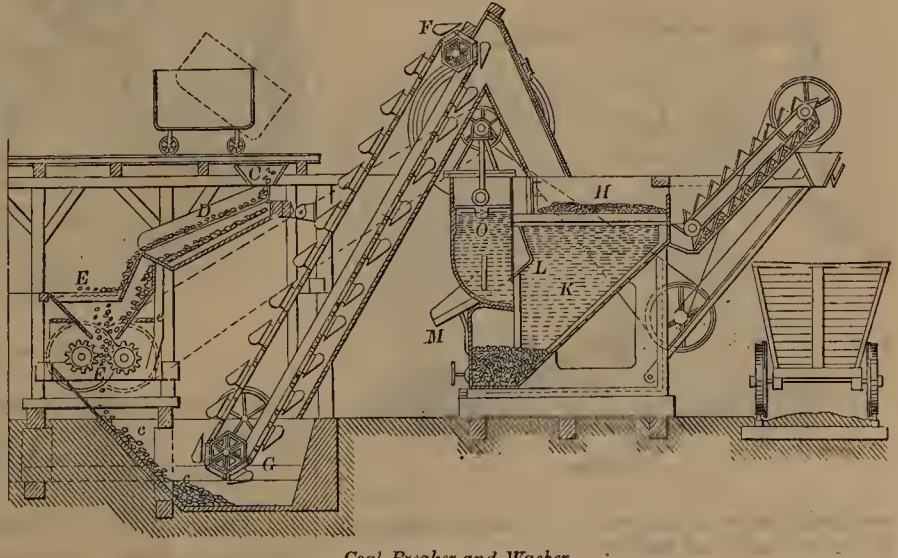


Coal-Breaker.

Erie Railway Company cost $300,000. Some in Schuykill County have cost over $200,000, and the new breaker of the Delaware, Lackawanna, and Western Railroad Company, near Hyde Park, cost in the neighborhood of $250,000.

In that invented by Berard, shown in Fig. 1354, the coal is carried to a hopper *C*, whence it falls on to a series of slanting movable gratings or perforated plates *D* suspended by chains or rods, and operated by a cam motion, by which it is sorted into various sizes. The larger pieces which fall through the first grating fall on the picking-table *E*, where stones and foreign substances are removed by hand, while the smaller coal passes from the second grat-

Fig. 1354.



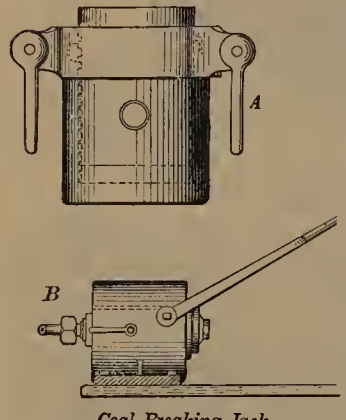
Coal Breaker and Washer.

ing on to the crushing-rollers *F*, and the finest of all, falling on a lower plate, is delivered by the shoot *c* into a pit *c*.

The rollers *F* have longitudinal and transverse grooves, forming projections which break up the thin fragments of slate mixed with the coal, without reducing the latter too much in size. It then falls into the pit *c*, whence the body of coal is elevated by the endless chain of buckets *G F* and carried to the sorter *H*, which separates it according to size for delivery to the boats or cars which are to receive it. The finest portions, which pass through all the gratings of the separator, fall into the tank or bac *K*, through which a current of water is forced by means of a cylinder and piston *O*, raising the broken pieces of slate sufficiently high to be forced through a perforated plate and discharged by the spout *L M*, the flow being regulated by flood-gates, while the coal, in consequence of its greater weight, falls to the bottom of the bac, from which it is removed as often as necessary through a suitable opening.

Coal-break'ing Jack. The jacks *A* are inserted in a small recess made in a seam, and a few feet of flexible tubing taken to an adjacent pump shown at *B*. On working the pump by means of the hand-lever great pressure is obtained, and the coal is brought down in large masses.

Fig. 1355.



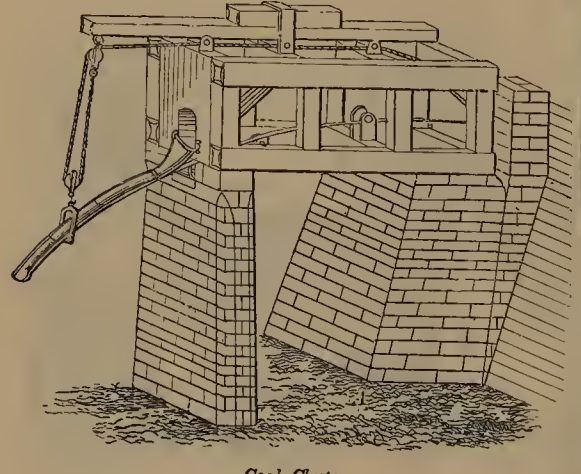
Coal-Breaking Jack.

Coal-bunk'er. (*Nautical.*) The closed room around the boiler and engine-room of a steam vessel for keeping the fuel.

Coal-car. A freight-car designed especially for coal, having facilities for dumping.

Coal-chute. A spout by which coal in bunkers or elevated boxes is loaded into cars or carts. In the illustration it is shown as extensible and verti-

Fig. 1353.



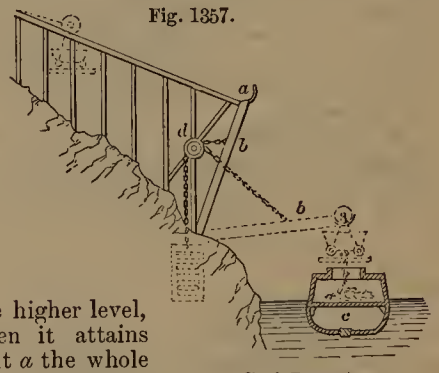
Coal-Chute.

cally adjustable; the former by a rod on rollers, the latter by block and tackle.

Coal-cut'ting Ma-chine'. A machine for under-cutting coal-seams in the mine or at the bank. See COAL-MINING MACHINE.

Coal-dump'ing Ap'pa-ra'tus. For loading vessels from the car. On top of the rail *a* which forms part of the *staith*, the laden carriage descends

Fig. 1357.

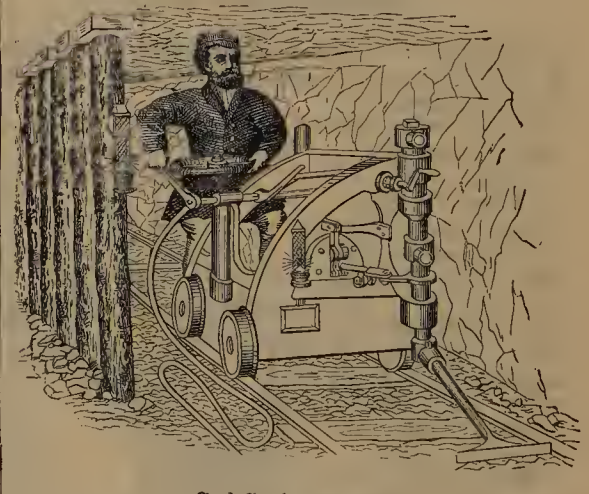


Coal-Dumping.

from the higher level, and when it attains the point *a* the whole frame *b* with the carriage is lowered down by the chain passing over the pulley at *d*, to the center of the deck of the vessel, and the coals deposited in the hold at *c*.

Coal-min'ing Ma-chine'. One form of the coal-cutting machine has an engine with a reciprocating piston driving a massive steel pick, in any desired direction, and at a very material saving in hewing, or *kirving*. The motive-power of the engine is highly compressed air, condensed by the steam-engine at the mouth of the pit, and this elastic air is conveyed by slender pipes down the shaft and along the mine to the breast where the coal is being worked. The compressed air is pumped by the steam-engine into a receiver at the pit-head during its otherwise idle hours, or by its surplus power when drawing up the coal, or pumping out the water from the mine, and is condensed to a tension of forty or fifty pounds to the square inch. It is conducted in metallic pipes, 4½ inches in diameter.

Fig. 1358.



Coal-Cutting Machine.

down to the bottom of the shaft, and thence in pipes of a smaller diameter to the workings, tubes of 1 or 1¼ inch caliber bringing it to the cylinder of the machine. This compressed air, when set free at each alternating stroke of the piston, imparts to the adjacent portions of the mine a pure, dry, cool atmosphere, from a well-known law of all air and

gases, that when compressed they develop heat, and when expanded under a relaxation of pressure, they are relatively cool.

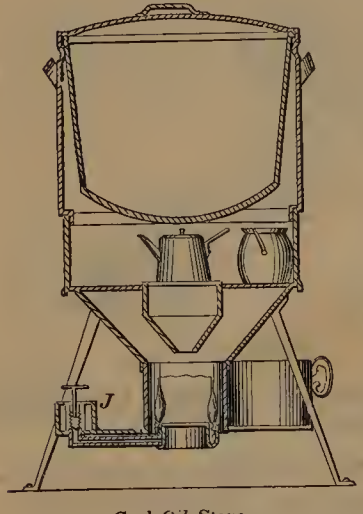
The machine is supported by a cast-metal frame of great solidity, and is of a size and weight proportioned to the character of the coal to be cut. It is constructed to give the blow of the pick, either by the pull or push of the piston.

The engine has an oscillating cylinder which has the merit of combining compactness of shape with but little complication of working parts. The machine rests upon flanged wheels and is propelled either backward or forward by a wheel and screw on a rachet and pinion, attached to one side of the engine. On the opposite side is a valve-screw for regulating by the hand the access of air to the engine. When working, the man seated upon the little stool in the rear of it moves the rachet-screw connected with the gearing of the under-carriage, and thereby propels the whole machine along the little railway or tram laid parallel to the front of the coal-seam, a small distance equal to the longitudinal nip or bite of the pick.

One machine, working 90 blows of the pick per minute, discharges, of condensed air, about 100 cubic feet per minute, which immediately becomes 300 cubic feet of cold air at the normal density, and each machine is competent to supply from 12 to 15 per cent of the ventilation required at the heading; the air being perfectly fresh, pure, and cool, and afforded precisely at the localities where the workmen are most in need of such an atmosphere. When working at 120 picks per minute, the machine cuts an inch at each stroke, 20 inches deep, 2½ inches wide; a second traverse deepens it to 30 inches, and a third to 36 inches.

Coal-oil Stove. One specifically adapted to cook or heat by means of coal-oil lamps. In the illustration, the burner is annular, and has a circle of wicks, the amount of oil being regulated by a screw-valve *J*. The parts of the stove are a hot-plate for cooking vessels, and a chamber above which may have an oven or a clothes-boiler.

Fig. 1359.



Coal-Oil Stove.

Coal-sack. A rough and strong bag, of hemp or jute, generally tarred, and used for conveying coals.

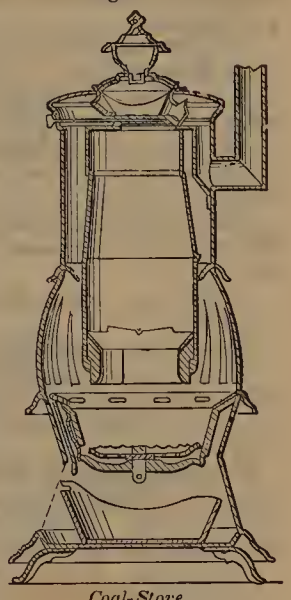
With the United States *portable* or *mountain* forge there is furnished a leathern coal-sack. It is 14 inches in diameter by 18 inches in hight, and of cylindrical shape.

Coal-screen. A sifter for coal. At the mines it is a very large cylinder with an inclined axis and portions of varying meshes, so as to sort the broken coal into sizes.

Coal-scut'tle. A box or hod for holding coals for present use.

Coal-stove. A stove for heating or cooking, adapted for the consumption of stone coal, as distinguished from charcoal or wood. The heating-stove is of many varieties, as the *magazine*, see Fig. 1360; the *cooking-stove; fireplace heater*, etc. See list under STOVES and HEATING APPLIANCES.

Fig. 1360.



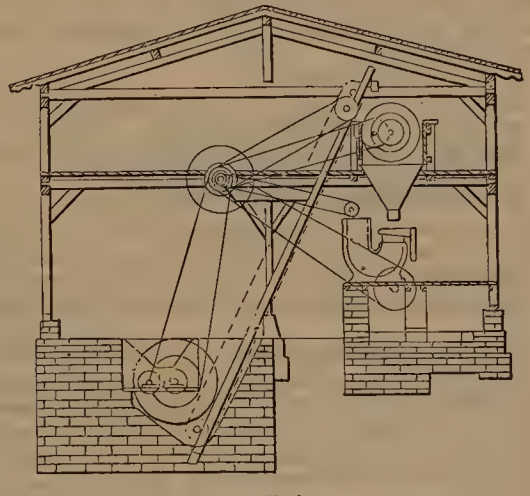
Coal-Stove.

Coal-tongs. A pair of tongs for grasping coal in lumps. *Fire-tongs.*

Coal-wash'er. A machine in which coal which has been broken and assorted is finally washed to deprive it of the dust and dirt adhering. See COAL-BREAKER.

In some operations it is worth while to sort, clean, and use certain portions of the fuel which have passed through the furnace. In Fig. 1361, the coal, ashes, and cinders are ground, washed, and elevated into a drum, where the material is assorted by fineness and passed to the shaking-machine, where the qualities are separated according to gravity.

Fig. 1361.



Coal-Washer.

Coam'ings. (*Shipbuilding.*) The raised border or frame of a hatchway, to prevent the water on the deck from flowing below. *Combings.*

The fore and aft pieces of a hatchway frame are *coamings*, those athwart ship are *head-ledges*. The former rest on *carlings*, which extend from beam to beam, and the latter rest on the deck beams.

Co-ap'ta-tor. (*Surgery.*) An apparatus for fitting together the ends of a fractured bone and holding them in position while the bony junction is proceeding.

Coarse-stuff. (*Plastering.*) The first coat of inside plaster-work. It is composed of common lime mortar, as made for brick masonry, with a small quantity of hair; or by volumes, lime paste, 1 part; sand, 2 to 2¼ parts; hair, ⅛ part.

Coast'er. A vessel employed in trading voyages from port to port, along a given coast.

Coat. 1. (*Nautical.*) A piece of tarred canvas, put about the masts at the partners, the rudder-casing, and also around the pumps, where they go

through the upper deck, in order to prevent water passing down.

2. A layer of plaster or paint.

Of plastering: —

A *scratch-coat* is the first of three coats; when laid upon laths it is from ¼ to ⅜ of an inch in thickness.

One-coat work is plastering in one coat without finish, either on masonry or laths — that is, *rendered* or *laid*.

Two-coat work is plastering in two coats, done either in a *laying-coat* and *set*, or in a *screed-coat* and *set*.

Screed-coat; a coat laid even with the edges of the screeds.

Floated coat; a first coat, laid on with a float.

Slipped-coat is the smoothing off of a brown coat with a small quantity of lime putty, mixed with 3 per cent of white sand, so as to make a comparatively even surface.

Coat'ing Met'als with Met'als. See GILDING; PLATING; ELECTRO-PLATING; SILVERING; GALVANIZING; PLATINIZING; etc. For list see METALLURGY; METAL-WORKING.

Coat-link. A pair of buttons joined by a link, for holding together the lappels of a double-breasted coat.

Co'balt. Equivalent, 29.5; symbol, Co.; specific gravity, 8.92. A reddish-gray metal. Fusing-point about 2800° F.

Oxide of cobalt gives the blue color to glass. This glass broken into fragments forms *smalt*.

Cob. 1. (*Mining.*) To break ore with a hammer to reduce its size, to enable its separation from portions of the gangue, and its assortment into grades of quality.

2. An unburned brick.

Cob'le. (*Nautical.*) A small fishing-boat, of great antiquity in the British Islands. *Coggle.*

Cob'ler. A bent rasp for straightening the shaft of a ramrod.

Co'bourg-cloth. (*Fabric.*) A lady's dress goods, cotton-chain, woolen-filling, twilled on one side. It may be considered an imitation of merino.

Cob-wall. A wall built up solid of a compost of puddled clay and straw, or of straw, lime, and earth.

Cob'web-mi-crom'e-ter. Invented by Ramsden (1735–1800). A micrometer in which cobwebs are substituted for wires. By turning the screw which approximates or separates the frames across which the cobweb-threads are stretched, the slightest alterations of the lines can be estimated, and a difference, even of $\frac{1}{100000}$ of an inch be rendered appreciable.

Coch'le-a. 1. An ancient term for an engine of spiral form. The screw whereby Archimedes launched the great galley of Hiero is also called *cochlea* by Athenæus. A *screw-jack*.

2. A spiral pump for raising water, as introduced by Archimedes into Egypt. The *Archimedean screw*.

Cock. 1. (*Horology.*) A bridge-piece fastened at one end to a watch-plate or block, and at the other end forming a bearing for a pivot; of the balance, for instance.

When the piece is supported at both ends, it is a *bridge*.

In *Lepine* watches, the wheels are pivoted in bridges instead of full plates.

2. The hammer of a gun-lock.

3. The gnomon or style of a dial. It represents the axis of the earth. It stands in the plane of the meridian, and its angle with the horizon is the latitude of the place. Mercutio may have referred to this when he made that very exceptionable remark to the nurse.

4. A faucet or rotary valve, usually taking its name from its peculiar use or construction, as: —

Blow-off cock.	Self-closing cock.
Cylinder-cock.	Steam-cock.
Feed-cock.	Stop-cock.
Four-way cock.	Three-way cock.
Gage-cock.	Try-cock.
Oil-cock.	Water-cock, etc., etc.

5. A vane.

6. A small boat.

7. A pile of hay. A cocking-machine gathers hay from the swath or windrow and puts it in cock.

8. The pointer of a balance.

Cock-bill. (*Nautical.*) An anchor is a cock-bill when it is suspended vertically from the cat-head. See ANCHOR, page 96.

Cock'et-cen'ter-ing. One in which head-room is left beneath the arch above the *springing-line*. Where passage beneath the arch is not required during the execution of the work, a *cocket-centering* is not needed, but the centering is constructed on a level tie-beam resting on the imposts.

Cock-eye. 1. (*Milling.*) A cavity on the under-side of the balance-rynd to receive the point of the spindle.

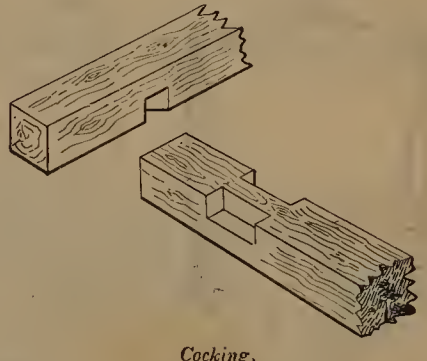
2. (*Saddlery.*) An iron loop on the end of a trace, adapted to catch over the pin on the end of a single-tree.

Originally *woodcock eye*, from the fancied resemblance of the thing to the head of the woodcock, the loop answering to the eye of the bird.

Cock-head. The upper point of a mill-stone spindle.

Cock'ing. (*Carpentry.*) *a.* A mode of fixing

Fig 1362.



Cocking.

the end of a tie-beam or floor-joist to a beam, girder, or wall-plate. *Cogging.*

b. Mortising.

Cock'le. 1. The hemispherical dome on the crown of a heating-furnace. See HEATING-STOVE.

2. A hop-drying kiln. An *oast*.

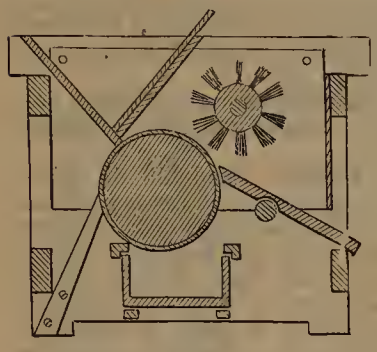
3. To buckle, or contract into wrinkles.

4. (*Porcelain.*) A large drying-stove used in a house where biscuit-ware dipped in *glaze* is dried preparatory to *firing*.

Cock'le and Gar'lic Sep'a-ra'tor. A machine for separating from wheat or other grain the seeds of cockle and the corms of the wild garlic, which is such a nuisance in some portions of the Atlantic slope.

In the example, the hopper has a small adjustable outlet through which the grain falls on to the perforated cylinder and is carried round and swept on the board by the revolving brush. The cockle drops

Fig. 1363.



Cockle and Garlic Separator.

through the perforations into the cylinder, and is carried round till it is discharged at the end into a drawer. Another mode of separating cockle and garlic is to give the roller a slightly adhesive surface, so that the rough-skinned cockle or the soft-skinned garlic may adhere thereto, and be carried off by the roller to be swept away, while the hard and bright-skinned grain refuses to adhere, and passes to a different receptacle.

Cock'le-stairs. (*Carpentry.*) Winding stairs.

Cock-met'al. An inferior alloy of copper and lead for making faucets. See ALLOY.

Cock-pit. (*Nautical.*) The after-part of the orlop deck. It is below the water-line and ordinarily forms quarters for junior officers, and in action is devoted to the surgeon and his patients.

Cock-spur. (*Pottery.*) A small piece of pottery used to place between two pieces of glazed-ware in the *saggar*, to prevent their adherence during the process of baking. *Stilts; triangles.*

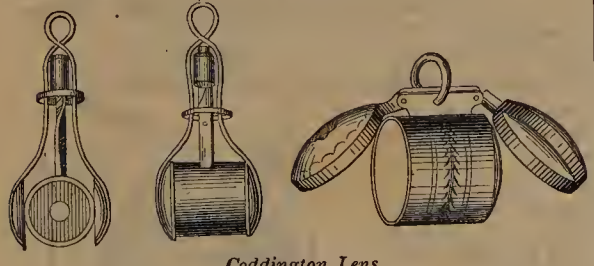
Cock-up Let'ter. (*Printing.*) A large letter standing above its fellows in the line, and formerly used for the initial letter of a book or chapter.

Co'coa. A palm (*Cocos nucifera*) from which the nut is derived. It also affords *coir*, from which ropes are made.

The name of the kernel from which the beverages cacao, broma, and chocolate are prepared, is sometimes corruptly spelt *cocoa*. See CACAO.

Cod'ding-ton Lens. A lens of spherical form having a deep equatorial groove around it in the plane of a great circle perpendicular as to the axis of vision. The groove is of such a depth that the stem

Fig. 1364.



Coddington Lens.

connecting the hemispheres has a diameter equal to $\frac{1}{8}$ of the focal length of the lens. This lens was invented by Dr. Wollaston, and called by him the *periscopic* lens; he made it by cementing together by their plane faces two hemispherical lenses with an annular, opaque diaphragm between them. Sir David Brewster improved it by cutting a groove in a whole sphere and filling the groove with opaque matter in order to diminish the quantity of light and prevent the confusion arising from the lateral rays.

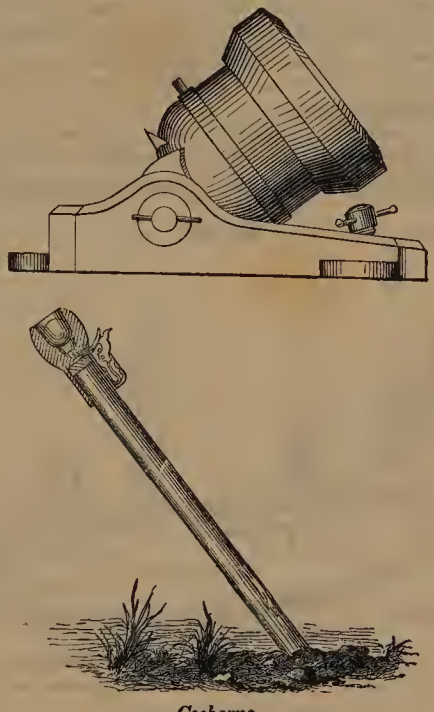
Cod-line. An 18-thread deep-sea fishing-line.

Cod'ling. A balk sawed into lengths for staves. It is cleft or *rived* into staves by means of a *frow* and *mallet*.

Coe'horn. (*Ordnance.*) A small mortar made light enough to be carried by hand, and adapted to throw a shell to a small distance. Used in fortifications and for signaling. The name is derived from its inventor, the Dutch Engineer officer, Coehorn, who was Director General of the fortifications of the United Provinces of Holland.

The regulation Coehorn mortar in the United States Service, is of brass, weighs 160 pounds, 24-pdr. caliber. It is mounted on a wooden bed having four handles by which it is carried by as many men.

Fig. 1365.



Coehorns.

The English coehorn has a bore of $4\frac{1}{2}$ inches, a length of 12 inches, and weighs, with bed, about 340 pounds.

Goodwin's coehorn is fixed on a stake and fired by a trigger and lanyard. It is a surprisingly effective little piece, throwing a three-inch shell to a great distance, and may be carried, one under each arm.

Cof'fee-big'gin. A coffee-pot with a bag to contain the ground coffee through which the boiling water is poured. The wire strainer is a substitute for the flannel bag.

Fig. 1366.

Coffee-Biggin.

Cof'fee-clean'ing Ma-chine'. A machine resembling a *bran-duster* or *smut* machine, in which the coffee grains are *beaten*, *rubbed*, *brushed*, and *winnowed* to remove the "parchment," or thin adhering envelope of the grain, and also purge it of dust and foreign matter. The devices are numerous, but generally consist of rotating beaters, rubbing surfaces, fans, etc.

Newell's patents, 1857 and 1859, may be taken as a type. A steam-heated cylinder, wire-gauze cylindrical envelope, rotating beaters.

Following these are about sixteen patents.

The object of some is to clean the grain; of others to "produce a yellow, brown, or golden color, to increase the commercial value."

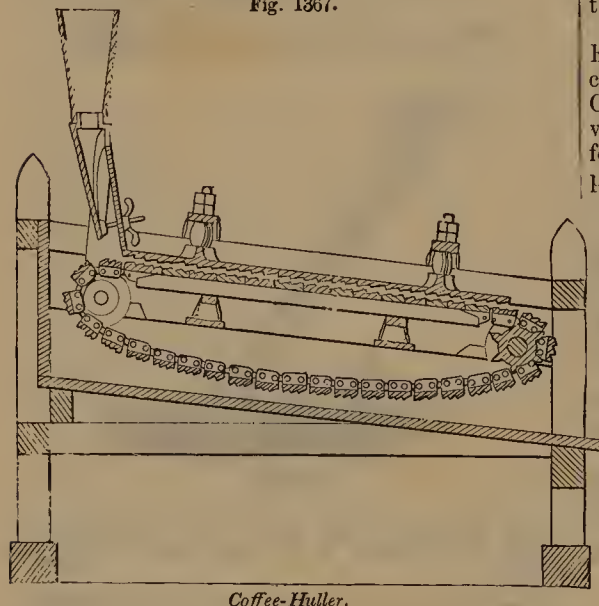
Sand and talc-dust are used by some to rasp the grain.

Cof'fee-hull'er. A machine to remove the husk or sac which covers the coffee-grains. It consists of an arrangement of serrated surfaces on a belt, or reciprocated past other serrated surfaces, between which the envelope is torn and loosened from the grain. Subsequent rubbing, brushing, dusting, and winnowing complete the process of hulling.

The *coffee cleaner* and *polisher* operates upon the grain subsequently.

The machine is similar to a rice-huller. Ditson's patent, 1835, has abrading surfaces made by perforating sheet-iron. See also Adams's patent, 1836.

Fig. 1367.



Coffee-Huller.

Subsequent to these are about ten others, which have certain peculiarities of construction. In the example, the husk is removed from the coffee while passing between the serrated blocks of the endless belt, and the serrated lower surface of the yielding plate.

Cof'fee-ma-chin'er-y. Coffee, as picked from the tree, looks like cherries, and is treated in Ceylon in the following manner: —

The berries are laid in heaps on the floor, whence they pass to the *pulpers*. These remove the flesh and skin, *sarcocarp* and *epicarp*, leaving two beans in a sac. The *pulper* is a stout frame supporting a fly-wheel, shaft, and barrel. The latter is of sheet-copper, punched from the inside so as to expose a grating surface to the fruit, which is fed on to it from a hopper and passes between the barrel and a chock, which forms a throat. The pulp passes off, while the beans in their envelope fall into a box beneath and are placed in cisterns where they are covered with water for twelve hours or so, in order to slightly ferment the mucilage which covers the membrane and prevent its hardening upon the skin.

After washing, it is placed on the *barbecues*, which are circular stone structures with polished plaster surfaces on which the beans are sunned for four days, while yet remaining in their envelope. It is thus dried sufficiently to be sent to Kandy, and thence to Columbo, where it undergoes a final treatment, consisting of curing, removing the covering, and picking out faulty berries.

In some establishments the beans are cured by a blast of warm dry air introduced into a chamber beneath the berries.

Cof'fee-mill. A small hand-mill in which roasted coffee-berries are ground by passing between the serrated surfaces of opposed steel disks or rollers, or roller and concave, as the case may be.

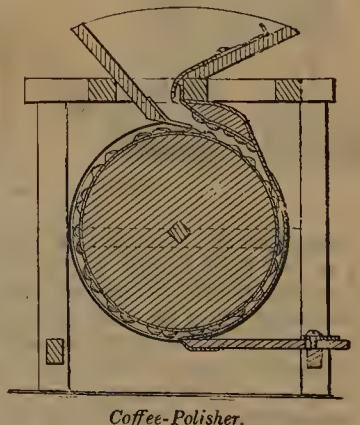
Coffee is the berry of the *Coffea Arabica*, a shrub of the order *rubiaceæ*, and its fruit resembles the cherry. Bruce says that it is native in Abyssinia. The use of the infusion as a beverage cannot be traced back very far. It was carried by Selim from Egypt to Constantinople, but does not appear to have been publicly sold till 1554. Its use was forbidden by the mufti, but again permitted by an edict of Solyman the Great. The Venetians brought it from the Levant in 1615, and in 1645 it was introduced into Marseilles.

Coffee was introduced into England by Daniel Edwards, a Turkey merchant, in 1657. The first coffee-house in England was in St. Michael's Alley, Cornhill, London; opened by Pasqua, a Greek servant of Mr. Edwards. It was then sold at from four to five guineas a pound. Coffee-trees were imported from Mocha by the Dutch about 1700, and thence carried to Surinam. In 1714 a coffee-plant was presented by the magistrates of Amsterdam to Louis XIV., and placed in the grounds at Marly. The progeny of this plant were carried to Cayenne and Martinique. In two centuries its use spread all over the civilized world.

The coffee-tree does not thrive where the temperature ever sinks below 55° F. It grows to the hight of 12 or 15 feet, has a leaf like the laurel, but not so thick. The blossoms are white, like the jessamine, and issue from the axillæ of the leaf-stalks. When they fade they are succeeded by the berry, which, as said before, resembles a cherry, is red when ripe, and has a yellowish, glutinous pulp, enclosing a sac containing two seeds.

Cof'fee-pol'ish-er. A machine for removing traces of mildew and stain from coffee as imported, or the effects of damp or heating in store. In the example, the coffee is discharged from the hopper upon the rim of a cylinder, covered with elastic material, and carried between the crushing plate or rubber and knobbed belt. The crushing plate is hinged and held in position by an elastic belt, the end of which is secured to an adjustable stretcher.

Fig. 1368.



Coffee-Polisher.

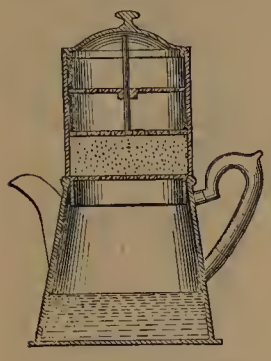
Cof'fee-pot. A vessel in which the infusion of coffee is made. Of the various kinds may be cited: —

1. The *percolator*, in which the infusion passes from the infusion-vessel through a strainer into a reservoir. This is effected by simple filtration, by pressure of steam, or by producing a partial vacuum.

The *percolator* was invented by Count Rumford.

The ground coffee is pressed between perforated diaphragms, so as by compactness to prevent the water from filtering through too quickly.

Fig. 1369.



Rumford's Percolator.

2. Coffee-pots having arrangements for condensing the steam and the essential oil, — which constitutes the aroma of the coffee, — and returning them to the infusion. An early arrangement of this kind is the Bencini patent, September 27, 1838. See also Martell's patent, 1825; Rowland, 1844; Waite and Sener, "Old Dominion," 1856. These have lids or upper chambers to condense the steam.

3. Coffee-pots of peculiar construction, as: —

Hotte, 1870; a furnace inside the coffee-pot.

Manning, 1869; an earthenware lining to a metallic pot.

Gibson, 1871; a flat breast to prevent lateral tilting when the pot is tipped forward.

Suspended on journals over a lamp and tipped on its bearings.

A strainer suspended from the spout.

Hot-water jacket.

Iron heater in reservoir; the urn.

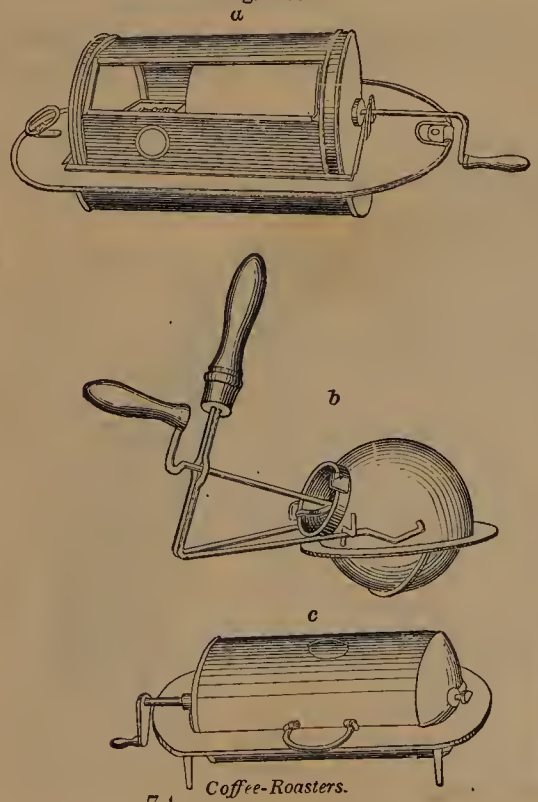
Divided chambers for tea and coffee, or coffee and water.

A piston to compress the ground and expel the infusion.

A piston to eject water in desired quantities from the water reservoir into the infusion.

Various arrangements of coffee-pots, of lamp-heated pots, and urns, may be seen in Webster and Parkes's "Encyclopedia of Domestic Economy," London, 1852, pp. 711–716.

Fig. 1370.



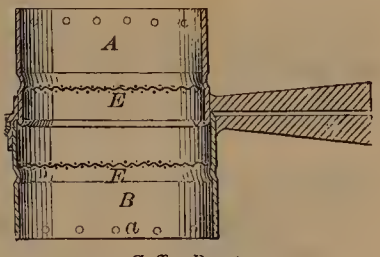
Coffee-Roasters.

Cof'fee-pulp'er. A machine for treating the coffee fruit by removing the pulp and the envelope of the seeds. See COFFEE-MACHINERY.

Cof'fee-roast'er. Two objects are attempted to be secured in coffee-roasters: to keep the berries moving and prevent their burning, and to keep the aroma confined as much as possible. The aroma depends upon the essential oil in the berry, and the empyreumatic flavor is developed by heat; or the oil is developed in the berry in the process of decomposition.

The coffee-roaster is generally of a cylindrical or prismatic form, and is rotated on a horizontal axis by means of a crank. In Fig. 1370, *a*, the base-plate is made to fit into the hole in a stove-top made by removing a pair of stove-lids and the center-plate between them, a protecting sheet beneath preventing the direct action of the fire upon the cylinder which rotates in journals above. The axial stud at each end is eccentric, those on the respective ends being on alternate sides of the center, so as to give a tumbling motion to the coffee, which is thus shaken from end to end of the cylinder as well as from side to side. A glass pane or slip allows the state of the process to be observed. The chamber is a polygonal prism, the plates forming the sides being more effective in tumbling the berries than are the smooth surfaces of a cylinder.

Fig. 1371.



Coffee-Roaster.

b (Fig. 1370) has a spherical chamber which occupies a stove-hole, and is revolved by the crank-handle while held in place by the other handle.

c is a cylinder mounted in a plate with legs.

Law's *coffee-roaster* (English) is a hollow sphere having a compound motion, revolving continuously in a horizontal plane and intermittingly in a vertical plane. URE, 1. 456.

Fig. 1371 has two cylinders *A B* with wire-gauze diaphragms *E E* hinged together and held closed by their handles. The coffee is contained between the foraminous diaphragms. The roaster is reversible, and sits upon the stove-top over a pot-hole.

Cof'fer. 1. (*Architecture.*) A sunk panel in a soffit or ceiling, deeply recessed by one or more separate faces, having the appearance of inverted steps, and enriched with moldings in the several internal angles, and with roses in the center.

2. (*Fortification.*) A hollow work across a dry moat to aid in repulsing a storming party by enfilade fire.

3. (*Hydraulic Engineering.*) A canal-lock chamber.

4. A large wooden vessel with movable ends to receive a barge or other vessel. A floating dock.

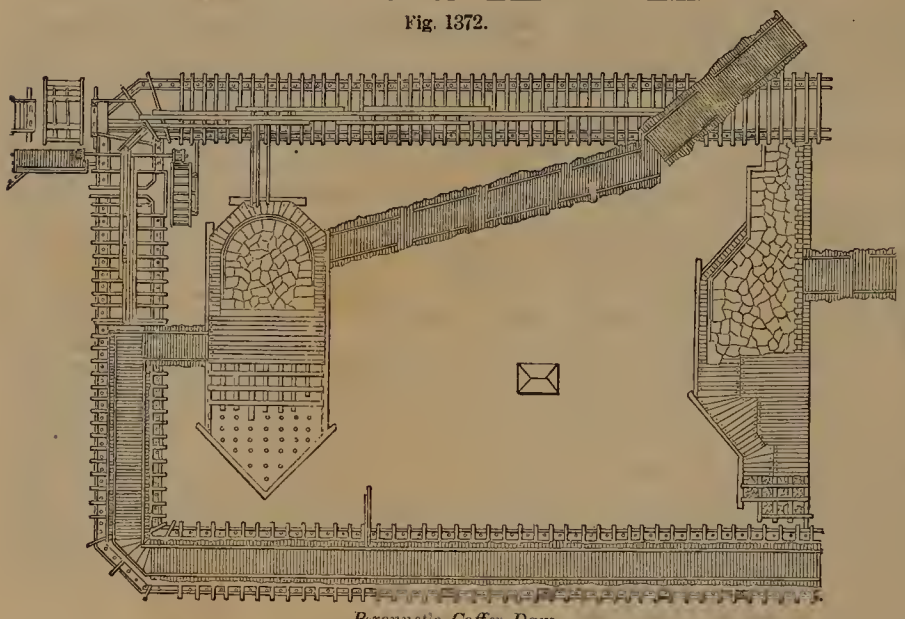
5. A casket for jewels.

6. A store-chest for muniments.

Cof'fer-dam. (*Hydraulic Engineering.*) A water-tight enclosure formed by piles driven into the bottom of a river and packed by clay, planks, or other stop-gap. It is used as a dam while laying bare the bottom of the river, in order to establish a foundation for a pier, abutment, or quay.

Peronnet's coffer-dams at the bridges of Mantes and Neuilly were made of two rows of piles, which were iron-shod, and driven with a monkey weighing 1,000 pounds. The mud was removed from the in-

Fig. 1372.

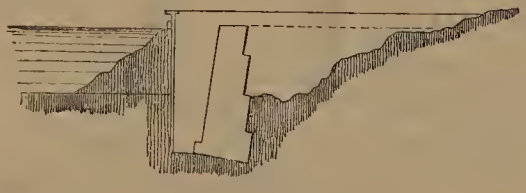


Peronnet's Coffer-Dam.

tervening space by means of dredging-machines and the space filled with clay, rammed down. The water from the interior of the dam was then pumped out.

Fig. 1373.

a



Coffer-Dam.

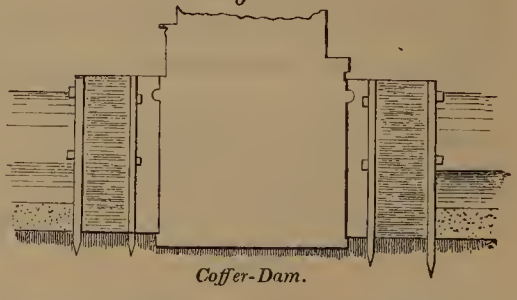
In shallow water and in situations but little exposed, a single row of piles sometimes suffices, the outside being protected with clay and an artificial bank *a*, Fig. 1373.

A sectional view *b*, Fig. 1374, will give a clear idea of the double wall of piles, between which the puddle is rammed to form a water-tight filling.

Instead of forming a double wall of piles in this manner, it has been suggested to dredge out the mud enclosed by the outer wall of circumvallation, then fill to a certain hight with *béton*. Upon this as a basis, an inner circle of shorter piles is driven, and the space between the walls puddled. The interior enclosure is then pumped out.

Fig. 1374.

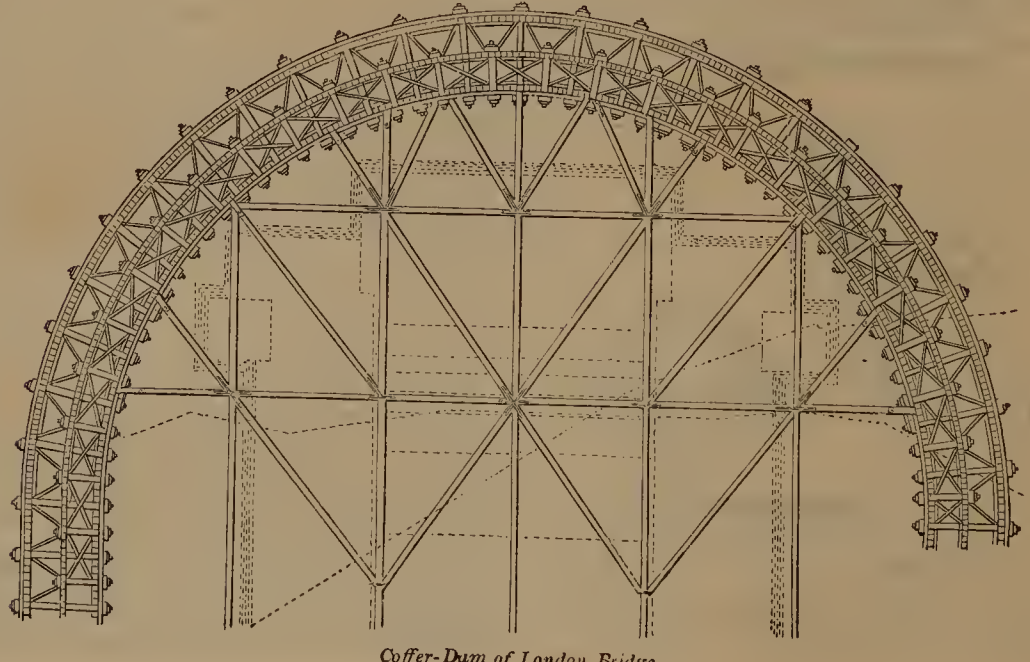
b



Coffer-Dam.

The pier coffer-dam of London Bridge (Fig. 1375) is described at length in Cresy. It is elliptical in form, and a portion of it is shown in plan in the figure. It was composed of piles not less than 12½

Fig. 1375.



Coffer-Dam of London Bridge.

inches square, driven in rows and braced by timbers and tie-bolts. The outer row and sheet walings and the spaces between rows were plugged with clay, the joints calked and covered with pitch. The piles were straightened, planed on the edges, and shod.

A coffer-dam built by the government engineers engaged in improving the navigation of the Mississippi River over the rapids of Rock Island is four thousand six hundred feet, or seven eighths of a mile long. It runs parallel with the shore, is from eight to fourteen feet wide, and near one million feet of lumber were used in its construction.

Cof'fer-ing. (*Mining.*) Securing a shaft from leaking by ramming in clay. See CAISSON; CURB.

Cof'fer-work. (*Masonry.*) Rubble-work faced with stone. See MASONRY.

Cof'fin. 1. (*Mining.*) *a.* A mode of working, *open to grass*, in which the bed of ore is uncovered by casting up the ore and attle by stall-boards, from one to another, to the surface.

b. An old exposed working.

2. (*Printing.*) The wooden frame inclosing the imposing-stone.

3. A receptacle to hold a corpse. A burial-case.

Joseph was put in a coffin in Egypt (Gen. l. 26), about 1650 B. C. This is the only mention of a coffin in the Bible; that mode of burial was never common among the Israelites, but Joseph's body was embalmed and coffined, according to the custom of his adopted country, and was taken out of Egypt by his countrymen when they left for Canaan, 1491 B. C.

The coffins of ancient Egypt were frequently stained to represent rare and foreign woods. The sycamore was the principal wood used, and it was handsomely painted, inlaid, and carved, according to their peculiar ideas and taste.

It must be admitted that Egypt has the palm of priority and skill in the subject of coffins. They had a good reason for exercising so much care, as they believed that in due time the spirit would return to the body, and they desired to keep it in the best order possible. We have no room to go into the subject of embalming, but may say, that the brain and viscera were withdrawn, the former at the nostrils, and the latter at incisions made by flint knives in the side of the abdomen. The cavities were then stuffed and the body bandaged, resinous and aromatic substances being employed to arrest decay. A box received the body and its wrapping, and the lid was tightly closed. The style of ornamentation can be best gathered by inspection of the mummies, or some of the beautiful volumes written by men who have made the subject a study. The work of the French professors, "Description de l'Egypte," made under the auspices of Napoleon, and Wilkinson's work on the manners and customs of the ancient Egyptians, will afford the best information extant, in book form.

The embalming process of the most expensive kind cost about a talent of silver, over $1,000 of our money. The processes were graded in price according to the ability of the survivors, the pecuniosity of the estate, or the ante-mortem directions of the defunct.

The illustration annexed is from a Theban tomb, exhibiting the trade of a coffin-maker. The men

Fig. 1376.

Coffin-Makers (Thebes).

are engaged upon the mummies, which are shown in two stages of completion. Some are applying the bandages, one is using the drill for some purpose in this connection, others are painting and polishing the case.

The coffins of the Ethiopians, exhibited to the emissaries of Cambyses, are thus described in Herodotus: — "They place the body in a crystal block which has been hollowed out to receive it, crystal being dug up in great abundance in their country, and of a kind very easy to work. You may see the corpse through the block in which it lies, and it neither gives out any unpleasant odor, nor is it in any respect unseemly; yet there is no part which is not as plainly visible as if the body was bare."

Book III., chapter 24, he speaks of the body being dried, and painted in imitation of health before inhumation; and of a corpse being treated as one of the family for a year after death, meals and attentions being scrupulously offered thereto.

The substance described as having been hollowed out for the reception of the mummy may have been glass, which was known in Egypt previous to this period, or it may have been the *lapis specularis*, or one form of gypsum.

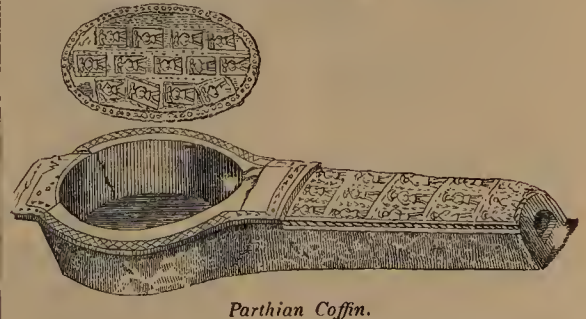
A sarcophagus of alabaster was (in 1845) in the museum of the late Sir John Soane, Lincoln's-Inn Fields, London. This, which is very elaborately carved and decorated, was discovered by Belzoni, in Upper Egypt.

It is the subject of the poem commencing, —

> "Thou alabaster relic! which I hold,
> My hand upon thy sculptured margin thrown."

Coffins of baked clay are found amid the ruins of the ancient cities of Mesopotamia. They are occasionally of wood. A common form of burial among the Hamite Chaldeans was to lay the body

Fig. 1377.



Parthian Coffin.

on a brick platform and then cover it with a dome of pottery, like a modern dish-cover.

Coffins from Warka, of green glazed pottery and shaped like a slipper-bath (see Fig. 1377), belonged probably to the Chaldeans of the Parthian age.

One sarcophagus of a Scythian king entombed at Kertch was found to be of yew wood, and had two compartments; one for the body, the other for weapons. The sarcophagus was in a large stone vault which contained the skeletons of a wife, an attendant, a horse, and divers jars, which probably once held provisions. It is pictured in Rawlinson's Herodotus, note to pp. 49, 50, Vol. III. (Am. ed.).

Sarcophagi of terra cotta, ornamented in bas-relief and with recumbent statues of the deceased, are found in the British Museum. See article "*Funus*," in Smith's "Dictionary of Greek and Roman Antiquities."

Glass coffins were patented in England in 1847. Unfortunately they were also used by the Egyptians over 2,000 years ago.

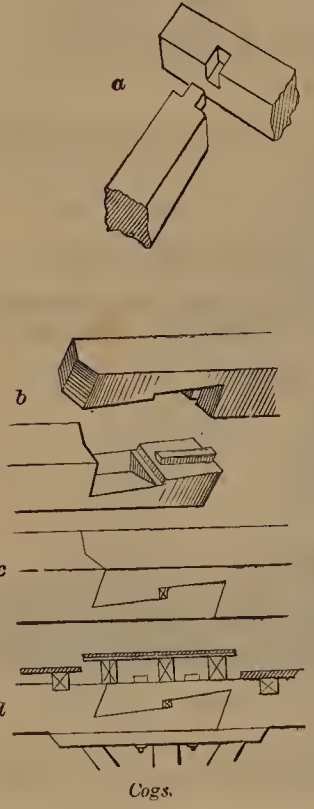
We learn from Pliny that Varro and others directed that their bodies, when dead, should be deposited in earthenware.

Coffins made of slate slabs united by metallic corner-pieces and bolts are described in an 1868 patent.

Coffins are rendered impervious to moisture by resins, asphaltum, paraffine, etc.

A Danish paper states that Herr Woerman, ship-owner of Hamburg, has been commissioned to procure a coffin for his present Majesty the King Iberio, on the west coast of Africa. The coffin is of fir-wood, polished on the outside, and furnished very comfortably. It is lined with red velvet, and has soft velvet cushions. There are five glass windows in the lid to let the light enter, and under it is placed a mirror for aid to reflection. The handles and feet are of tin, as well as the window settings; and, lastly, the coffin arrangement is completed by two bottles of gin and the necessary glasses. The prospect of death is rendered cheerful by the continual presence of the box in his Majesty's state apartments.

Fig. 1378.



Cogs.

4. (*Milling.*) One of the sockets in the eye of the runner, which receives the ends of the driver.

The term is applied to other depressions, especially to such as are hollowed or chipped out.

Coffin-gage. An instrument, cross-shaped, with graduated stem, head-piece, and arms, by which the measurement of a corpse may be readily made.

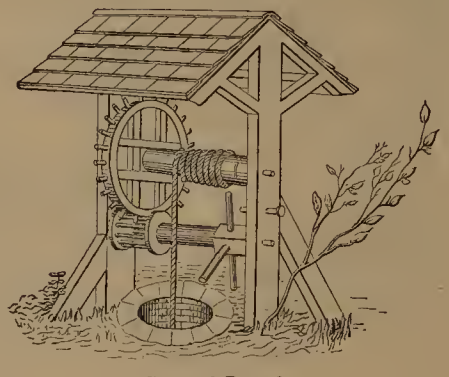
Cog. 1. A tooth, cam, catch or lifter, which acts upon an object to move it; as in the case of a gear-wheel; the wiper on the shaft which lifts a trip-hammer, or the pestle of a stamp-mill; the projection from the arbor of a stop-motion, or from a disk in a register or feed motion, etc.

2. (*Carpentry.*) *a*. A projecting piece *a* on the end of a joist, which is in the nature of a tenon, and is received into a notch in a bearing timber, such as a wall-plate, the cog resting flush with the upper surface of the plate.

b. A longitudinal tenon *b c d* projecting from one of the faces of a scarf-joint and entering a recess in the face of the other timber, to prevent lateral deflection of the scarf-joint. A *coak*.

Cog and Round. An old-fashioned bucket-hoist having a *cog*-wheel and lantern, the latter having staves or *rounds*.

Fig. 1379.



Cog and Round.

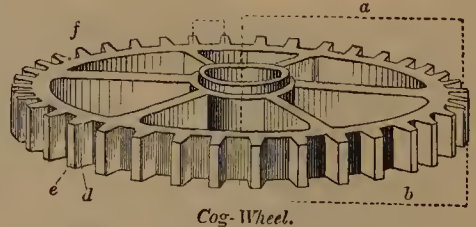
Cog-wear. An old-time narrow frieze goods, of coarse quality.

Cog-wheel. One having teeth which mash into similar ones on another wheel to impart motion thereto, or to receive it therefrom. The name — *cog* — shows the original mode of construction, in which *cogs* or pieces of wood were inserted into mortises in the face of a wheel. Wheels thus constructed are used under the names of *rag* or *sprocket* wheels, in connection with chains or *lantern* wheels, the latter having *rounds* or *rundles* between disks.

The teeth of cog-wheels are now usually made solid with the rim, being cast therewith or cut thereupon.

There are numerous varieties of cog-wheels, known by peculiar shapes, modes of presentation of the wheel, or by special features of the teeth. A list is given under GEARING (which see).

Fig. 1380



Cog-Wheel.

A *spur*-wheel has cogs projecting radially, either inward or outward.

A *crown* or *contrate* wheel has cogs projecting from the rim parallel with the axis.

A *bevel* or *miter* wheel has teeth whose faces are oblique with the axis.

The *pinion* bears a specific relation to a larger cog-wheel.

For list of cog-wheels, see GEARING.

In the illustration a *spur*-wheel is shown, the cogs being radial.

The characteristic parts of the wheel are as follows: —

a, *primitive* or *geometric radius;* distance of the center of the wheel from the *pitch-line*.

b, *true* (or *real*) *radius;* distance of center of wheel from extremity of cog.

The *addendum* is the difference between the real and geometric radius.

Interdental space; the interval between cogs.

The *pitch c* of a wheel is the distance measured along the pitch-line from the center of one tooth to the center of the next.

The *pitch-surface* of a wheel is an ideal smooth surface, intermediate between the crests of the teeth and the bottoms of the interdental spaces, which, by rolling contact with the pitch-surface of another wheel, would communicate the same velocity-ratio that the teeth communicate by their sliding contact.

The *pitch-line* of a wheel, or, in circular wheels, the *pitch-circle*, is a transverse section of the *pitch-surface* made by a surface perpendicular to it and to the axis; that is, in *spur*-wheels, by a plane perpendicular to the axis; in *bevel*-wheels, by a sphere described about the apex of the conical pitch-surface; and in *skew-bevel* wheels, by any oblate spheroid generated by the rotation of an ellipse whose foci are the same with those of the hyperbola that generates the pitch surface. (RANKIN.)

The *pitch-point* of a pair of wheels is the point of contact of their pitch-lines.

The *crest* of a cog is its extreme outer surface.

The *face e* of a cog is the acting surface beyond the pitch-line. *f* is the shoulder.

The *flank d* lies within the pitch-surface.

The substitution of the iron for the wooden wheel is originally due to Smeaton, who introduced iron wheels at Carron, in Great Britain, in 1754, and at Belper, Derbyshire, shortly after. A cast-iron bevel-wheel was also used in Scotland about the same time by Mr. W. Murdock. Not until 1784, however, was cast-iron fairly introduced in the various details of mill work, and the credit of this wider application of the improvement belongs to John Rennie, an eminent and successful engineer, who adopted it for bevel and spur wheels at Boulton and Watt's, at the Soho Rolling Mill and Foundry.

Cog-wheels were formerly distinguished from toothed wheels by the former having teeth of different materials from, and inserted into, the rim.

This distinction is not now very usual.

Coil. 1. A helix or spiral; the word is used to indicate variously convolved forms.

It seems proper that the term "coil" should be considered generic, including both the helical and spiral forms.

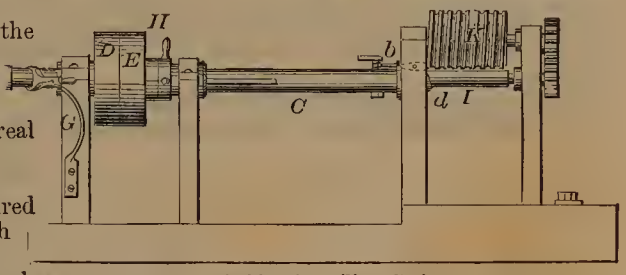
Helical, appertaining to a *helix*, which is a coil decreasing in radius as it approaches the center; whether in the same plane as a coil of rope, or a watch-spring, or assuming a conical shape, as with *helixes* of shells.

Spiral, shaped like a wire wound upon a cylinder; as the spring of the chronometer, the spring-balance, etc. The coils have the same diameter.

2. (*Nautical.*) Rope laid up ring fashion, *fake* on *fake*. When laid up in a flat helix, without riders, beginning in the middle, and "with the sun," it is said to be a Flemish coil.

Coiled-spring. A metallic spring laid up in a spiral so as to have a resiliency in the line of its axis, either by extension or condensation, as the spring may be arranged. Fig. 1381 shows one mode of coiling springs in which the wire is wound on a revolving mandrel, the end being held by a sliding sleeve and locking dog. The wire is coiled upon

Fig. 1381.



Machine for coiling Springs.

the mandrel *I* as it rotates, by a spirally grooved cylinder *K*. The coil is stripped from the mandrel by the longitudinal movement of the latter.

The uses of such springs are so numerous that it will be impossible to enumerate a large proportion of them. Springs for railway cars, spring-balances, bed-bottoms, etc. See Fig. 1143, page 483.

Coin. A piece of metal on which certain characters are stamped by authority, giving the piece a legal current value.

No coin has been found of the ancient Egyptians or Assyrians; neither do the Phœnicians appear to have coined money.

The money of ancient Egypt was in the form of rings, which were of gold and silver, *a b c d*, fig. 1382. The same currency, we learn from Wilkinson, is in use in Senaar and the neighboring countries. The Egyptians had no coin till the time of Alexander, 330 B. C., except a few of the Persian, and some made in imitation, which cost the viceroy his life.

The Chinese and Japanese have also ring-money.

Money was originally estimated by weight, as in the case of the sum paid for a piece of land by Abraham to Ephron the Hittite, and the money "in full weight" found in the corn-sacks of Joseph's brethren. In the Theban paintings, the public weigher is shown in the act of weighing money. See BALANCE.

To avoid the trouble of weighing the metal whenever a purchase was made, or of cutting it to make fractions, pieces of a known weight were ready cut and introduced into circulation. These were marked with their weight; afterwards devices, such as the name or figure of the king, were placed upon them to confer authenticity, and thus coins were established.

Chinese bronze and copper money was made as early as 1100 B. C., but none of gold or silver till a much later period.

The brass money referred to by Homer as existing 1184 B. C. was bronze, and may have been merely pieces of known weight. Herodotus states that the Lydians first coined money about 1000 B. C. This was at the period when Solomon paid Hiram in corn, wine, and oil, for the use of his skilled workmen and his cedar-wood.

The early coins of Lydia show a punch-mark on the reverse, the *quadratum incisum*, given by a protuberance on the anvil upon which the planchet of metal was laid to receive the impression of the die, which was laid above and struck by a hammer. The punch-mark on the reverse was afterwards converted into a regular impression in intaglio. The lion device of Lydia was probably adopted on coins by Crœsus; other Lydian coins have the archer, which was copied on the Persian *daric*.

The different states of Greece adopted various animals for emblems.

The earliest representations of the human form

designed as portraits, are the Macedonian series, commencing with Alexander, the son of Amyntas.

One form of Greek money, before the introduction of coin, was in *skewers*, of which six formed a *handful*.

An early gold coin was the Persian darlic *c*, Fig. 1382, which weighed about 130 grains troy. Silver

Fig. 1382.

Ancient Money.

coins in imitation were struck by Aryandes, governor of Egypt under the Persians, for which act he was condemned to death. Silver is said to have been coined by Phedon of Argos, 750 B. C. Gold by Philip of Macedon, 340 B. C. Servius Tullius coined copper money, 578 B. C. Silver was coined at Athens, 512 B. C.; at Rome, 269 B. C. Iron was coined by Lycurgus, 884 B. C. Plutarch says it required a cart and two oxen to draw the small sum of 10 minæ, about $28.

It is said that the coin of Philip of Macedon was the first that was alloyed; it was done to harden it, and make it wear better.

Coined money was first cited in those portions of the Hebrew Scriptures written after the captivity. The Jews had no coined money of their own till the time of the Maccabees, when King Antiochus gave leave to Simon to "coin money for his country with his own stamp." (1 Maccabees xv. 6.)

The money mentioned by Ezra was probably the Persian daric *e*, Fig. 1382, equal to about $5.50. Cyrus paid the soldiers of Clearchus a daric a month. (Xenophon.)

The Jewish silver shekel had a weight of about half an ounce, and value about 62 cents of our money. To form an idea of the economic value of money, do not forget to consider the relative value of provisions.

f g are the obverse and reverse of the shekel.

h i the obverse and reverse of the half-shekel.

j is an obverse with the inscription, "Shekel of Israel."

k the reverse of the same coin, with "Jerusalem the Holy," and a vase having three flowers.

The coins of Herod are of copper or brass, and are abundant, numismatically speaking. The obverse *l* has an inscription and anchor; the reverse *m* has two cornucopiæ, within which is a caduceus.

The *shekel*, *stater*, *drachma*, and *denarius*, representing three different nationalities, were current in Palestine.

Barkabab, who raised a politico-religious crusade against the Romans in the time of Hadrian, closed the series of Jewish coins (*o p*), for after this Jerusalem, as a Jewish city, disappears altogether, and under the name of Ælia, A. D. 135, became a Roman colony from which Jews were rigorously excluded. Constantine restored the name and made it a Christian city about A. D. 326. Five centuries of peace, a long period for Jerusalem, followed the restoration under Constantine and Julian. Then followed the Persian, Chosroes II., A. D. 614; Heraclius retrieved it in 628; but Omar subdued it, A. D. 637. The Christians regained it but for a brief and bloody interval of 87 years, in the eleventh and twelfth centuries, when it was conquered by Saladin, became nominally attached to the Kingdom of Sicily in 1277, and in 1517 passed under the sway of the Ottoman Sultan, Selim I., whose successor Suliman built the present walls of the city in 1542.

The stamping of metal to form coin was originally performed by a common punch, by a succession of blows, making a rude impression, more or less perfect, according to the skill of the workman. An instance of this is an early silver coin of Ægina with the emblematical tortoise.

The *stater*, the principal gold coin of ancient Greece, was, perhaps, the earliest coin, and the mode of its manufacture was characteristic of coinage for a long period. The obverse has a rude image of a lion's head, and the reverse has an indentation. A single die was used, and the piece of metal placed on it; a punch drove the metal into the intaglio of the die, and the marks of the punch remained on the reverse.

The first improvement upon this consisted in placing a device on the face of the punch, giving a design to the reverse in intaglio. This was not, in the first place, similar to the cameo relief of the obverse, as may be seen in the quarter-stater of Phocea. Then followed a coinage in which the obverse and reverse showed the same design, — one in relief and

the other in intaglio. The next step was evidently to make two dies with intaglio faces, between which the planchet or piece of metal was swaged so as to give the design in relief on each side. To this we still adhere.

The first designs on coin were emblematical or else indicative of weight, that is, value. The emblems were various, as in the case of the tortoise of Ægina, or the owl of Athens, and were afterwards supplanted by figures or heads of deities, who presided over the destinies of the respective countries or cities.

The silver coin of Alexander I., of Macedonia, 450 B. C., is said to have been the first which had a representation of the human figure; and the drachma of Archelaus, 413 B. C., the first coin with a portrait. This practice was not adopted by the Romans till the time of Julius Cæsar, when it became general, and is yet practiced, as is well known. The Mohammedans, in their detestation of images, inscribe the name and title of the prince, and on the reverse the name of the coin and the year of the Hegira. The crescent, found on some Byzantine coins, was adopted as a symbol by the Turks.

"King Abderahman (Ben Moavia) had his zeka, or house for the coinage of money, in Cordova; he introduced no change in the currency, but retained the dies used in Syria by the Caliphs, who were his predecessors, and made his coins in all respects similar to theirs, . . . excepting what was necessitated by time and place." — CONDÈ.

Justinian II. was the first who had the image of Christ struck on coins, A. D. 710. The Pope's effigy first occurs on a coin in 1480.

The *as libra*, in the time of Servius Tullius (550 B. C.), weighed a pound, as its name indicates; by 190 B. C., it had fallen to half an ounce. Silver was coined 269 B. C., when the denarius weighed 90 grains; in the time of Vespasian, A. D. 70, it had fallen to 53 grains. The aureus was first issued about 204 B. C., and weighed 166 grains, but had fallen to 96 grains in the time of Heliogabalus, A. D. 218.

The silver coinage of Crotona, 600 B. C., was pure, as was also the gold coinage of Philip of Macedon, 350 B. C. Under Vespasian, A. D. 79, the silver money contained one fourth its weight of copper. Under Antoninus Pius, A. D. 138, more than one third. Under Commodus, A. D. 180, nearly one half. Under Gordian, A. D. 236, more than two thirds of the so-called silver coin was copper. Under Gallienus, A. D. 361, a coinage was issued, an alloy of copper, tin, and silver, of which the latter formed less than a two hundredth part. The Republic debased the coin by reducing its weight, the Empire by alloying it.

Pieces of copper and of tin, of known weight but irregular shape, were used in Britain, till Cunobelin, King of the Trinobantes, who had been educated at the court of Augustus, imitated the Roman coin; but under Claudius the British mint was destroyed, the Roman coin introduced, and continued in circulation till the arrival of the Saxons.

Assaying in England originated with the Bishop of Salisbury, treasurer to Henry I., about 1130. It was practiced by the Romans.

In the reign of Edward I. the penny was so deeply indented with a cross that it was easily divided into half-pence and fourthlings (farthings).

Henry III. issued the first gold coin in England, 1257. Edward III. issued gold coin in 1344, and at that time the armorial bearings appear on British coins.

Pounds sterling, crowns, and shillings were issued by Henry VIII., half-crowns and sixpences by Edward VI. The guinea, so called from being made of African gold, was issued in 1663, and stamped with an elephant. The name "sovereign" (English pound sterling) was of later date, reign of James I. The screw-press was invented by Bucher, a Frenchman, in 1553, and was established in the English mint in 1602. The edge was grained at first to prevent clipping. A motto was placed on the edge in 1651.

The first coin or medal with milled edges is said to be that of George Frederick, Marquis of Brandenburgh, 1589.

The "angel," value 6s. 8d., first coined A. D. 1430. The obverse represented Michael the Archangel with his left foot on the dragon.

The first government copper coinage in England was in 1620. Copper tokens had been issued previously by corporations and individuals.

"At my goldsmith's did observe the king's (Charles II.) new medall, where, in little, there is Mrs. Stewart's [afterwards Duchess of Richmond] face, as well done as ever I saw anything in my whole life, I think; and a pretty thing it is that he should choose her face to represent Britannia by." — PEPYS's *Diary*, Feb. 25, 1667.

The alloy (English) of gold is silver and copper, and of silver, is copper. English standard gold is 22 carats gold to 2 of alloy. Standard silver is 11 oz. 2 dwts. silver, to 18 dwts. copper. The American gold coin is 36 parts gold, 3 parts copper, 1 part silver.

The American and French silver coin are 9 parts silver, 1 part copper. See STANDARD.

The proper weight of the double-eagle is 516 troy grains, and the smaller gold coins in proportion. The law permits a variation above or below the standard of half a grain. See REMEDY.

The series of operations in coining is as follows:—

1. The ingot is assayed and alloyed.
2. A number of ingots melted into a long, flat bar.
3. The bar is repeatedly rolled, cut into pieces, annealed, and re-rolled until it assumes the shape of a ribbon, approximating the width and thickness of the required coin.
4. The ribbon is *drawn* through a gage to bring it to exact size.
5. The ribbon is cut into blanks, each planchet being of the weight, and approximately the size, of the coin.
6. The planchet is tested by an automatic weighing-machine, which rejects heavy and light, and selects those of proper weight.
7. The edge of the planchet is *milled*, that is, rolled smooth and circular and slightly turned over.
8. The *planchet* is heated, cooled in water, cleansed in acidulated water, and then dried in hot sawdust.
9. The *blank* is stamped between the die and counter-die, the *nurling* being done at the same operation.

Coin-as-sort'er. A machine which separates different kinds of coins by size, or coins of the same kind by weight.

In one form of the first mentioned, the coins are put singly into a hopper and fed edgeways to the inclined way, in which they roll upon their edges and lean toward the open side of the way, so as to drop out on arriving at an aperture large enough therefor. The distance between the holding lips of the guides constantly increases, so that the coins will drop out at different places, each into its appropriate tube. The tubes are marked by a scale, to indicate the number of coins by the depth of the pile.

In another form, the coins pass into a graduated series of rotary cylindrical sifters or sorting-barrels,

with internal spiral divisions, causing the coins to travel through and between each spiral thread ; circular openings allow all the coins except the largest to drop through. The largest coins are delivered into a till, but the remainder pass through other barrels, until only the smallest ones remain.

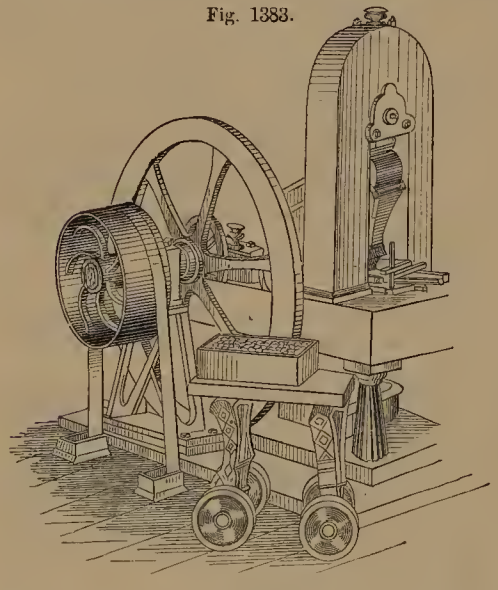
In machines for sorting gold or silver coin into full-weights and light-weights, the scales are arranged so that the coin of full weight in a lower position is pushed off by an automatic pusher into one box, but the light-weights are lifted a little higher by the rising of the scale, and are brought opposite to another pusher which sends them into a light-weight box.

Coin–count'er. An arrangement by which the process of hand counting, piece by piece, is dispensed with. A shovel or tray has shallow depressions of a given length, width, and depth to hold so many coins of a given kind. The coins are shoveled into the tray, which is then skillfully agitated until the coins have snugly occupied all the spaces. The remainder are brushed off, and the complete quota is thrown into a scale to verify the count by weighing.

Coin'ing–press. A power lever-screw press by which the planchet of metal is impressed with the design or legend.

The blanks are placed in a tube at the front of the press, and at each motion the lower blank in the pile is seized by fingers and drawn into a collar between the upper and lower dies ; where as the lever descends, the two arms of the toggle-joints are

Fig. 1383.



Coining-Press.

brought into line perpendicularly, imparting a powerful pressure to the blank, causing it to fill out the collar and forming at the same time the face and obverse impressions, as well as the flutings or nurling on its edge.

The piece is then released by the relaxation of the toggle-joint allowing the upper die to rise ; the lower die rises sufficiently to discharge the coin from the collar, and the fingers, returning with a second blank, push the first out and allow it to slide into a box below. The coins are then examined to detect defective pieces, as flaws sometimes occur from air-bubbles in the original cast ingots ; and, after being counted by means of a special apparatus for the purpose, are placed in bags.

The lower die is on what is termed the *die-stake*, and gives the reverse impression. The obverse is in the upper die.

The pressure in coining double-eagles is about 75 tons.

Coin–weigh'ing Ma-chine'. A machine for weighing coin and assorting them according to their *full* or *light* weight.

The gold coins are placed in a pile, and the bottom one is shifted by a slide along a channel just large enough for the standard gold coin, but too large for a counterfeit, and is deposited on the scale supported by a knife-edge upon the beam. The forceps, which temporarily detain the weight-scale, are then let go, and if the coin be light that end of the beam will rise and the other end leaves the agate point which rests upon it ; a bolt then advances and pushes off the coin into a light-weight receptacle. If the coin be full weight, the scale remains down ; the lower bolt knocks it off into a full-weight box at a lower level ; the position of the coin at a lower or a higher elevation determines which of the bolts shall strike it, and at which eduction aperture it shall depart.

Coir. The prepared fiber of the husk or pericarp of the cocoa-nut, which is made into rope, matting, brushes, etc.

The nut is picked a little before it is ripe, and the pericarp stripped from the nut by forcing it upon an iron stake fixed in the ground. The rind is then soaked in water for several months to soften the substance which fills the interstices between the fibers. It is then beaten upon a stone with a heavy piece of wood, and then rubbed by the hands. Forty cocoa-nuts yield six pounds of *coir*.

The operation of twisting it into yarn is similar to that pursued with hemp.

Coir cordage is lighter than hemp, is pliable, and has a strength, compared with hempen rope, of 87 to 108 with large rope, and 60 to 65 with small rope.

It is well adapted for hawsers, as it is light enough to float in sea-water, and also for running-rigging, but is not so well adapted for standing-rigging, owing to its contractibility.

Coir is also made from the long, fibrous, black, cloth-like covering of the *Borassus gonnutus*.

Coke. Charred pitcoal.

It is carbonized in heaps, in ovens, or in the retorts of the gas manufactory. It may be remarked that the production of the best coke and the best gas from the same coal is incompatible ; the bulk of the mass is increased by coking, the weight diminished from 30 to 55 per cent, according to the mode of conducting the process.

As the distillation of wood leaves a solid residue of charcoal, so is coke the residue of the distillation of coal. 2,240 pounds, a long ton, of bituminous coal is said to yield 8,000 to 10,000 cubic feet of carbureted hydrogen gas, and 1,100 to 1,300 pounds of dry, brittle coke.

Sir John Hacket and Octavius de Strada proposed in 1626 to convert coal into coke, and thus make it as agreeable a fuel for chambers as wood or charcoal.

In 1658 the project was revived by Sir John Winter, who constructed a fire-cage 11 inches high, and a box below with an ash-pit door, which was opened when the fire was to be urged.

The manufacture of coke in heaps is thus managed : —

An oblong square hearth is prepared by beating the earth to a firm, flat surface, and puddling it over with clay. The pieces of coal are then piled up on this, leaning against each other, and each with its acutest angle resting on the hearth. The piles are from 30 to 50 inches high, 9 to 16 feet

broad, and contain from 40 to 100 tons of coal. A number of vents are left, reaching from top to bottom, into which the burning fuel is thrown, and they are then closed with small pieces of coal beaten in hard. The fire creeps along the bottom, rises gradually and equally, and bursts out on every side at once. If the coal contain pyrites, the combustion is allowed to proceed a considerable time after the disappearance of the smoke, to extricate the sulphur. If it contain no sulphur, the fire is covered up soon after the smoke disappears, beginning at the bottom and proceeding gradually to the top. In from fifty to seventy hours the heap is covered completely, and in from twelve to fourteen days the coke is ready for removal.

The coke of gas-works is obtained from the charred coal, withdrawn from the retorts and quenched with water.

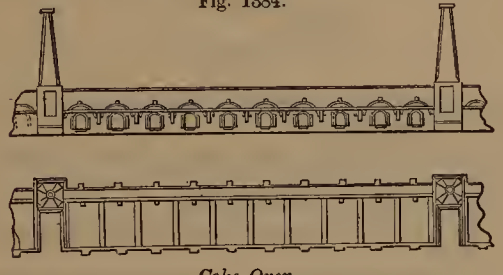
Coke-fur'nace. A furnace in which the volatile matters are expelled from pit-coal, leaving a residual carbon which burns without flame and makes an intense heat. A *coke-oven.*

Coke-ov'en. An oven in which the gas is expelled from coal, leaving the coke or carbonaceous portion.

A heap of coal enclosed with earth so as to limit the access of air, and provided with small holes to allow the escape of gases, may be fired and will produce coke. Coke-ovens are similar in principle, and have openings above for charging with coal, openings below for withdrawing the coke, and means for graduating the admission of air.

When made on a large scale, a number of large ovens are placed in a row, and a railway is laid

Fig. 1384.



Coke-Oven.

along the top for the coal-cars, which dump their contents into the ovens. A lower railway affords a track for the cars which receive the coke from the ovens.

The coke-ovens of the London and Birmingham Railroad are eighteen in a series, with flues at the back leading to a chimney 11 feet internal diameter, wall 3 feet thick at the base, 115 feet high.

Each oven is elliptical, about 11 × 12 feet. The charge is 6,720 pounds. Forty hours suffice for the coking. It is then withdrawn and watered. The loss in weight, 20 per cent. It gains one quarter in bulk.

Col'an-der. A strainer formed of perforated sheet-metal.

The *colum* or colander of the Greeks and Romans was used for straining the must from the pulp and skins of the grapes; the oil from the *amurca;* and for domestic purposes. They were made of perforated bronze or silver; of hair, broom (*spartium*), or rushes.

Several were found at Pompeii.

A beautiful bronze colander was exhumed near Heliopolis, and is in the Abbott collection. The holes are drilled in small patterns. It has a handle.

The colander for pouring lead in the making of shot is a hollow hemisphere of sheet-iron, about 10 inches in diameter, and perforated with holes which are free from burs.

The holes have nearly the following diameters for the annexed sizes of shot:—

No. 0	. . . .	$\frac{1}{10}$ of an inch.
1	. . . .	$\frac{1}{18}$ "
2	. . . .	$\frac{1}{26}$ "
3	. . . .	$\frac{1}{42}$ "
4	. . . .	$\frac{1}{80}$ "

by gradations to No. 9, which is $\frac{1}{360}$ "

Instead of a *colander*, an oblong ladle is now used in some towers, the edge being scalloped to break the overflow into small streams.

Col'an-der-shov'el. One of wire open-work, for shoveling salt crystals out of the evaporating-pan.

Col'ar-in. (*Architecture.*) The space, frequently ornamented, between the astragal and the annulets of the capital of the Tuscan or Roman doric column.

Col'co-thar. A red oxide of iron, obtained by the calcination of sulphate of iron, and used for polishing. See CROCUS; GRINDING MATERIALS.

Cold-blast. (*Metallurgy.*) Air forced into a smelting-furnace, at a natural temperature, in contradistinction to a heated blast, which is more economical, but produces an inferior quality of iron.

Cold-chis'el. A steel tool used for cutting metals, and driven by the blows of a hammer.

Cold-drawn. Oil expressed from seeds or nuts without previous heating of the latter, is said to be *cold* drawn; and is of superior quality to that yielded by previously heated seeds or nuts.

Cold-ham'mer-ing. The hammering of a metal, without fire-heat, to give hardness and temper.

Cold-short. (*Founding.*) A void or seam in a casting occasioned by the too rapid congelation of the metal which failed to fill the mold perfectly.

Cold-short Iron. Iron containing phosphorous, which may be forged and welded while hot, but is brittle when cold.

Cold-shut. A term meaning that a link is closed while cold, without welding.

Cold-wa'ter Pump. (*Steam-engine.*) A pump by which the condenser cistern is supplied with cold water.

Col'lar. 1. (*Machinery.*) A ring or round flange upon or against an object. Its purpose may be:—

A. To restrain a motion within given limits, as:—

a. The *collar* or *butting-ring* on an axle, which limits the motion inward of the hub on the axle.

b. The ring shrunk upon, or an annular projection or enlargement of a shaft or rod which keeps it from slipping endwise.

c. A short sleeve on a shaft.

d. The neck of a bolt.

B. To hold an object in place; as:—

a. The plate of metal screwed down upon the stuffing-box of a steam or pump cylinder, and having a hole through which the piston passes.

b. The ring inserted in a lathe puppet for holding the end of the mandrel next the chuck, in order to make the spindle run truly.

2. (*Engineering.*) The curb or steining around the top of a shaft to restrain the friable superficial strata and to keep loose matters from falling in.

3. (*Nautical.*) An eye formed in a bight of a shroud or rope, to pass over a mast-head, to hold a dead-eye or a block, or for other analogous purposes.

4. (*Harness.*) A roll of leather stuffed with straw, etc., and having two creases to hold the

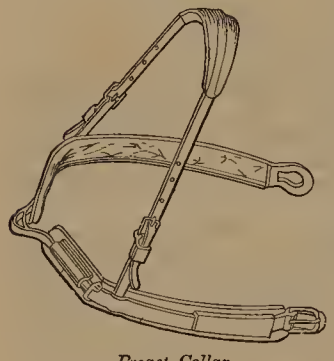
hames. It is placed around the neck of the horse, fits against the shoulders, and forms the bearing against which the horse presses in drawing the load.

The parts of the collar are: —

The *withers;* the upper bow resting on the neck of the horse.

The *after-wale, body-side,* or *pad;* the portion behind the hames.

Fig. 1385.



Breast-Collar.

The *fore-wale,* or *small roll.*

The *housing;* a covering to shed rain from the collar and shoulder.

The *collar-strap;* at the upper end.

The *breast-collar,* so called, is a breast-strap, forming a substitute for a collar.

5. (*Architecture.*) *a.* A ring or cincture. An astragal.

b. A beam staying two opposite rafters at a point between the comb and the plates. See COLLAR-BEAM.

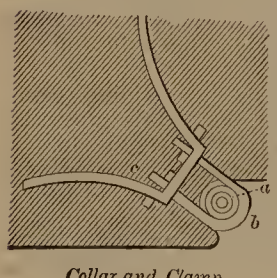
6. (*Coining.*) A steel ring which confines a planchet and prevents lateral spreading under the pressure or blows of the coining-press. When the edge of the coin is to be lettered, the letters are sunk in the collar, which is in three pieces, confined by an outer ring.

7. (*Clothing.*) A band around the neck, or the neck portion of a body garment. Shirt-collars, or what are made to appear as such, are made of paper, paper and cloth combined, cloth, leather, metal. They are made reversible, are embossed in imitation of lace, linen, stitching; printed in imitation of various kinds of figured goods; stained to resemble certain kinds of fabrics. Paper collars are made combined with bosoms or with neck-ties, or both, with peculiar fastenings or with reinforced button-holes.

Their manufacture involves machines for cutting, punching, folding, molding, shaping, embossing, planishing, burnishing, and boxing.

The process of making paper collars is briefly as follows: — Sheets of paper, preferably 16 × 36 inches and weighing 125 pounds to the ream, are enameled, dried, embossed to imitate cloth by roller pressure between plates on which cloth has been tightly stretched and pasted. The sheets are polished by revolving brushes; cut in heaps of eighty thicknesses by steel dies of the shape required; reinforced by patches of fabric at the button-holes; the button-holes cut, stitches impressed on the border, and the size stamped on them. The collar is molded to fit the neck, rolled up in dozens, so called, but more often only ten; put in a box, labeled and cased.

Fig. 1386.



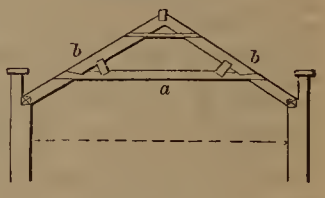
Collar and Clamp.

Col'lar and Clamp. The ordinary form of dock-gate hinge. Also known as *anchor and collar.* The anchor *c* is let into the masonry, and the collar is formed by a clevis *b*, whose legs are secured by fore-locks in the clamp. *a* is the hole for the pintle of the leaf.

Col'lar-awl. (*Saddlery.*) A form in which the eye-pointed needle has been used for many years. It is used in sewing collars, the wax-end being passed through the material by its means, and drawn tightly by the hands.

Col'lar-beam. A tie-beam *a* uniting the breasts of a pair of rafters *b b*, to keep them from sagging or spreading. It acts as a strut, a tie, and often as a ceiling joist for a garret story.

Fig. 1387.



Collar-Beam.

Col'lar-block. (*Saddlery.*) The harness-maker's block on which a collar is shaped and sewn.

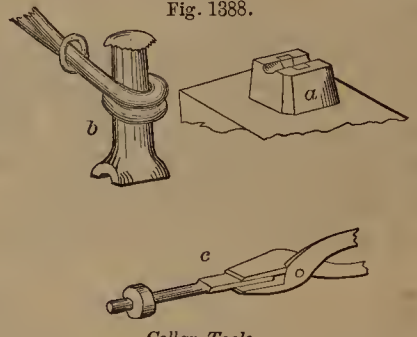
Col'lar-check. A heavy woolen goods made for saddlery purposes.

Col'lar-har'ness. Harness with a collar in contradistinction to *breast-harness.*

Col'lar-plate. An auxiliary puppet, or midway rest in a lathe for turning long pieces.

Col'lar-tool. (*Forging.*) A rounding tool for the formation of collars or flanges on rods by a process of swaging.

Fig. 1388.



Collar Tools.

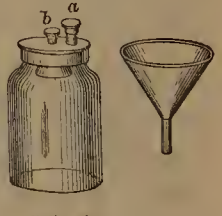
a represents the lower half of the tool in the *hardy-hole* of the anvil.

b is the upper or *fullering* tool.

c shows the collar and rod in the grip of the pinchers.

Col-lect'ing-bot'tle. A microscopist's tank for collecting and retaining objects dipped from ponds. The funnel *c* fits in the tube *a* when the cover of the latter is removed. The tube *b* has a cover of fine muslin.

Fig. 1389.



Collecting-Bottle.

Col'let. 1. (*Machinery.*) A small band of metal; as the ring which fastens the packing of a piston.

2. (*Jewelry.*) *a.* The part of a ring containing the *bezel* in which the stone is set.

b. The flat surface which terminates the *culasse* or lower faceted portion of a *brilliant-cut* diamond. It is sometimes called the lower table or culet, and is one fifth of the size of the upper one.

Coll'ier. (*Nautical.*) A vessel employed in carrying coals by sea.

Col-li-ma'tor. A telescope arranged and used to determine errors of collimation, both vertical and horizontal. (NICHOL.) A collimating eye-piece has a diagonal reflector for illumination, and is used to determine the error of collimation in a transit instrument, by observing the image of a cross-wire reflected from mercury, and comparing its position in the field with that of the same wire seen directly.

The error of collimation is the deviation of the line of collimation of an astronomical or geodetical instrument from its normal or correct position with respect to the axis of motion of the instrument. (WEBSTER.)

The floating and the vertical-floating collimator were invented by Captain Kater, and are two instruments of similar principle and of not very different construction, designed to facilitate the adjustment of circles. The former is used for determining the horizontal point, and the latter the zenith or nadir points, as the case may be. Each kind consists of a telescope (with a system of cross-wires in its field) which is made to rest in a horizontal position on a plate of iron floating on a surface of mercury; or is fixed vertically in a frame, at the lower part of which is an iron ring whose plane is at right angles to the axis of the telescope, the ring floating on mercury in an annular vessel. The telescope of the circle which it is desired to adjust being duly put in position, the observer looks through it, either upward or downward, as the case may be, to the telescope of the collimator, which, in the vertical instrument, is mounted with its axis coincident with the axis of the ring. The adjustment consists in bringing the cross-wires of the two telescopes to a mutual intersection by the screw movement of the circle. G. CHAMBERS.

Col'lish. (*Shoe-making.*) A tool to polish the edge of a sole.

Col-lo'di-o-chlo'ride Proc'ess. A photographic printing process invented by George H. Simpson, editor of the Photographic News, about 1863. It consists in holding in suspension a precipitate of chloride of silver in collodion, which is flowed upon glass or paper — in a manner similar to preparing a plate for the negative process — and dried in the dark. The sensitive surface so produced blackens on exposure to light, and will consequently give a picture under a photographic negative. An excess of free nitrate of silver is necessary to impart sensitiveness; an addition of citric acid and other organic substances is used to produce the desired tints. After exposure the picture is fixed and toned as usual.

Col-lo'di-on-proc'ess. A process in photography invented by Archer. An *iodized collodion* is made by impregnating a solution of gun-cotton in ether, with a small quantity of iodide of potassium or cadmium. A film of the iodized collodion is spread on the glass, which is then immersed in a solution of nitrate of silver. The image is taken in the camera, developed by a weak solution of pyrogallic acid and acetic acid, or a solution of protosulphate of iron. Excess of iodide of silver is removed by hyposulphite of soda or cyanide of potassium.

This gives a *negative*. A positive is obtained by laying the negative on prepared paper and exposing them to light.

Col-lo'di-o-type. (*Photography.*) Or collodion-process. A name applied to those processes in which a film of sensitized collodion is used on a plate in obtaining an image. In the *wet* collodion process the plate is exposed while moist; in the *dry* collodion process the plate is first dried.

The collodion *positives* are *melanotypes* and *ambrotypes;* the images are formed on the collodion, so as to be viewed by reflected or transmitted light. When viewed by reflected light they are termed *ambrotypes.*

Collodion *negatives* are obtained on a film of sensitized collodion on glass.

Col-lu'-vi-a'ri-um. An opening in an aqueduct to allow access for cleaning or repairs, and for ventillation.

Col'on-nade'. (*Architecture.*) A range of columns, whether attached or insulated, and supporting an entablature.

Co'lon. A punctuation mark (" : ") prescribing an interval greater than a semicolon.

Col'or-doc'tor. (*Calico-printing.*) *a.* A roller of gun-metal or steel pressed against the face of the engraved roll for calico-printing, and receiving a tremulous motion to slightly abrade the copper surface and enable it to hold the color more effectually.

b. A sharp-edged ruler of gun-metal presented at a tangent upon the engraved cylinder of the calico-printing machine. The *doctor* acts as a wiper to hold back superfluous color, and has a slight reciprocating motion in contact with the surface of the cylinder. A *lint-doctor* on the other or delivery side of the roller removes fibers of cotton from the cylinder.

Col'ored Fires. Compositions, generally based on powder or its components, used in pyrotechny for making various ornamental fire-works, known as *lances, stars, lights, wheel-fires, sun-fires,* etc.

Col'ored Light. A pyrotechnic display or signal for effect or preconcerted purpose. One formula for their composition is as follows: —

1. White light: 8 parts saltpetre, 2 parts sulphur, 2 parts antimony.
2. Red light: 20 parts nitrate of strontia, 5 parts chlorate of potash, 6½ parts sulphur, 1 part charcoal.
3. Blue light: 9 parts chlorate of potash, 3 parts sulphur, 3 parts mountain blue (carbonate of copper).
4. Yellow light: 24 parts nitrate of soda, 8 parts antimony, 6 parts sulphur, 1 part charcoal.
5. Green light: 20 parts nitrate of baryta, 13 parts chlorate of potash, 10 parts sulphur.
6. Violet light: 4 parts nitrate of strontia, 9 parts chlorate of potash, 5 parts sulphur, 1 part carbonate of copper, 1 part calomel.

Col'ored Glass. A glass used to interpose between the light and its illuminated field; used as a signal for railways and ships; also in lighthouses to give a marked peculiarity to the light by which it may be recognized; also for purposes of display.

Col'or-im'e-ter. A measurer of color. For various forms, see list under METER.

Col'or-print'ing. Printing by a succession of colors, or by various colors occupying parts of the sheet. There are various modes. See CHROMATIC PRINTING.

Co-los'sus. A statue of gigantic size.

The largest statue in Egypt, according to Diodorus Siculus, was that of Osymandyas, in the Ramesion. It is the Memnonium of Strabo. The pedestal is still standing; the court around is filled with its fragments. The foot, of which parts remain, must have been 11 feet long and 4 feet 10 inches broad; the breadth across the shoulders 22 feet 4 inches; the hight is calculated at 54 feet, the weight 1,985,438 pounds.

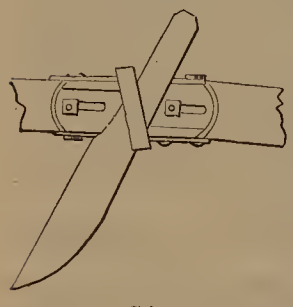
The statues of Memnon are 60 feet in hight, including the pedestal. The latter is 13 feet high, but is half buried in the alluvial soil. The material is a coarse, hard breccia, with imbedded chalcedonies. The southern figure is in one block. The northern one was broken before the Christian era, and was repaired with sandstone, in five pieces, by one of the Roman emperors, probably Severus.

The colossi of antiquity (Greek and Roman) are enumerated in Smith's "Dictionary of Greek and Roman Antiquities," p. 322.

Col-rake A shovel used to stir lead ores while being washed.

Colt'er. A knife or sharp-edged bar, usually secured to the beam, and projecting downward in front of the breast of a plow. Its duty is to make the incision in the soil in advance of the share, making a vertical cut the width of the furrow-slice which is to be cut below by the share and turned over by the mold-board. In the West it is usually termed a cutter, the term "colter" being applied to those which extend down in front of the share and have a depression in the rear to receive a lug on the point of the share, the colter being continued on in front to form the entering-point. The colter, in this case, is supported in the rear by the point of the share; in the ordinary mode the point of the colter projects into a notch on the upper edge of the share, and is supported thereby. Sometimes, instead of passing through a slot in the beam and being secured by a wedge, or being secured to the beam by a shackle, the colter is bent at right angles, and its shank slips into staples on the sheth, resting parallel with the upper edge of the land-side.

Fig. 1390.

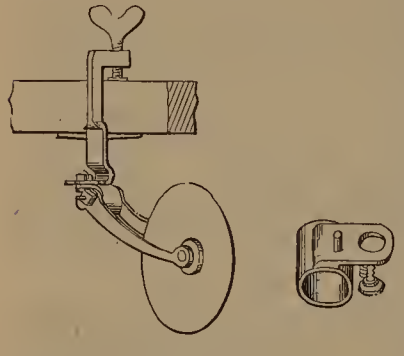


Colter.

The ancient plow consisted of a beam and a colter, the latter doing all the work, instead of being merely subsidiary to the main working parts. The colter is not now considered a necessary part of most plows, except for plowing sod, when it is useful in cutting the roots and enables the plow to do clean work.

The word is from the Latin *culter*, a knife. Not all knives were known by that name, but a heavy description with a straight edge, curved back, and sharp point.

Fig. 1391.



Wheel-Colter.

In Fig. 1390 the colter is shown as secured by a side-bar and shackle. The wheel-colter in Fig. 1391 is mounted as a caster-wheel. It has long been employed in the fen lands of England.

Colt's Pis'tol. A revolving pistol first patented by Colt in 1835, and perfected in 1845. See REVOLVER.

Col'um-ba'ri-um. 1. A hole left in a wall for the insertion of the ends of a timber; named from its resemblance to a niche in a pigeon-house.

2. A niche in a mausoleum for a funereal urn was also so called.

Co-lum'bi-ad. An improved gun introduced by Colonel Bomford, of the Ordnance Corps, United States army, about 1812. It was made proportionately thicker at the breech and smaller at the muzzle than the guns theretofore in use, and was the precursor of the Paixhan gun of the French army (introduced in 1822), the Dahlgren, and the Rodman.

Co-lum'bi-er. A size of drawing-paper measuring $34\frac{1}{2} \times 23$ inches, and weighing 100 pounds to the ream.

Co-lum'bi-um. A rare metal, so named from having been first discovered in America. Now called *niobium*. Once called *tantalum*.

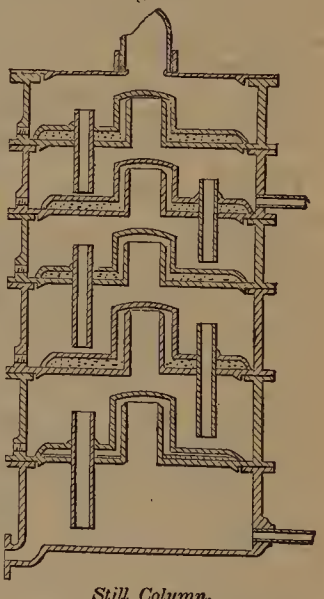
Col'umn. 1. (*Architecture.*) A vertical support of the nature of a pillar.

It usually has three members, — the *capital*, *shaft*, and *base*. The capital has an *abacus*, the base frequently a *plinth*.

Early Egyptian columns were fluted. The Ionic volute was from Persepolis. The Doric is Egyptian. The Corinthian is an improvement on the Egyptian. The pediment is Grecian, as are also all the fine and skillful proportions of parts. Ornamented architraves are from the land of the Nile. Figures for columns, resembling the Atlantes and Caryatides of the Greeks, are found in old Egypt.

2. (*Printing.*) A perpendicular set of type or printed lines; usually said of matter separated from another set or bounded by a vertical rule or line.

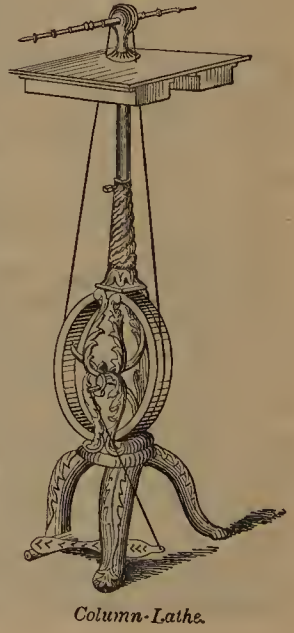
Fig 1392.



Still Column.

3. (*Distilling.*) A vessel containing a vertical series of chambers used in stills for continuous distillation; such as Coffey's, in which the two columns are known as the *analyzer* and the *rectifier*. In Fig. 1392, it consists of a series of chambers placed one above the other, the lower one communicating with the vessel. Steam is admitted, and passes up through the pipes into the chambers, being compelled, by means of hoods, to descend in its passage, and enter the chambers beneath the surface of the liquid contained therein. The chambers are partially filled from above with the liquid to be distilled, the pipes distributing the liquid from the top to the bottom chamber of the series.

Fig. 1393.



Column-Lathe.

4. (*Calico-printing.*) The name of a certain description of steam apparatus by which steam is applied to cloths topically treated with a mixture of dye-extracts and mordants, in order to fix the colors.

The *column* is a copper cylinder 44 inches long and 5 inches diameter, perforated with $\frac{1}{16}$th inch holes, at distances of $\frac{1}{4}$ inch. Round it are lapped a few folds of blanket, then of white calico; the goods are then wound on, the pieces being stitched together; over all are a

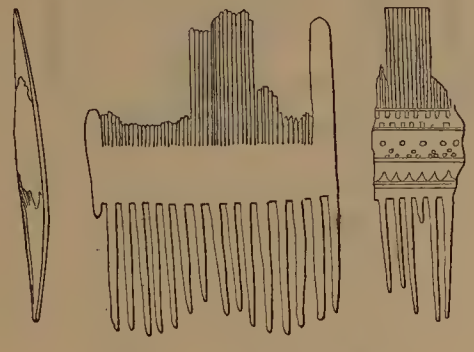
few thicknesses of white calico. The *column* is then placed vertically, and the steam admitted to its inside is emitted through the holes, saturating the cloth and fixing the colors. The process takes twenty or thirty minutes.

Col'umn-lathe. A dentist's or watch-maker's lathe on a vertical extensible post to accommodate an operator in a sitting or standing posture.

Col'umn-rule. (*Printing.*) A brass slip to separate columns of type.

Comb. 1. (*Toilet.*) An instrument with a row of teeth for cleaning, straightening, and adjusting the hair.

Fig. 1394.



Egyptian Combs (Thebes).

The combs of ancient Egypt were made of wood or ivory, and generally double, one side having finer teeth than the other.

The Greeks had also combs with two rows of teeth like our fine-tooth combs. Such have been found in Pompeii. They and the Romans used combs (*pecten*) of boxwood from the shores of the Euxine.

The women of China wore ivory combs in the ninth century A. D. The comb of the Patagonians and Fuegians is the jaw of a porpoise.

Combs derive their names from purpose, form, or material, as: —

Back-comb.	Horn-comb.
Child's round-comb.	India-rubber comb.
Dress-comb.	Ivory comb.
Fine-tooth comb.	Metal-backed comb.
Folding-comb.	Round-comb.
Gutta-percha comb.	Tortoise-shell comb.
Hair-comb.	

A comb was formerly used to drive up the woof-thread to compact the fabric in weaving. It remains in the modern reed. Combs are used in the same manner by the modern Hindoos.

Combs for removing the grain from the straw (wheat or flax) were used in Egypt and in Rome. See Ripple.

2. A rake-shaped implement consisting of a head with two or three rows of tapering steel teeth, the rows being of different lengths.

The tool is used in *combing* long-stapled wool for worsted goods. The combs are used in pairs. Short-stapled wool is *carded*.

The combs or cards for wool-carding are shown in the illuminated manuscripts and missals of the Middle Ages, so called. (See Fig. 1395.) A pair of cards were as necessary an article of furniture in a house as a distaff. It is more truly a pair of *combs* than of *cards*, and the wool is evidently long-stapled. This would be indicated by the pot of hot water in which the combs are placed.

3. The serrated doffing-knife which removes the fleece from the doffing-cylinder of a carding-machine.

Fig. 1395.

A Lady carding Wool.

4. (*Hat-making.*) The former on which a *fleece* of fiber is taken up and hardened into a *bat*. Probably from *cone*, the usual shape.

5. A steel tool with teeth corresponding to those of a screw, and used for chasing screws on work which is rotated in a lathe. See Chaser.

6. The projection on the top of the hammer of a gun-lock.

7. The notched scale of a wire-micrometer.

Comb-broach. The tooth of a wool-comb.

Comb-brush. A brush to clean combs.

Comb-cut'ter's Saw. This is usually a double saw, in which two blades are affixed to one stock, one projecting beyond the other, and the less salient acting as a spacer to start the next kerf.

Another comb-cutter's saw has an adjustable slip, which acts as a gage for depth of kerf. See Comb-saw.

Comb'er. (*Nautical.*) A ledge around the well or passenger portion of a sail-boat to keep back spray and waves which "comb" over the deck.

Comb-frame. A four-square removable frame like a slate-frame, placed in a hive to be filled with honeycomb.

Com'bi-na'tion-at-tach'ment. (*Sewing-machine.*) A device to be attached to the sewing-machine proper, and by which two or more distinct classes of work may be performed, such as *marking*, *folding*, and *creasing* a tuck; a *guide*, *hemmer*, *corder*, and *quilter*. See "Sewing-Machine Attachments," published by George W. Gregory, Washington, D. C.

Com'bi-na'tion-fuse. A fuse combining the principles of time and percussion, so that if the time-fuse fails to explode the shell after the proper interval, the percussion device will produce this effect when the shell strikes.

Comb'ing. An operation in the worsted, or long-wool manufacture. The operation of straightening and disentangling wool; corresponding in purpose with *carding* of short wool.

In hand-combing, the work is done between two combs, one held stationary, and the other drawn over it, to comb out the lock of wool placed between them. The combs have a number of steel spikes fixed into a back, and are occasionally heated in a *comb-pot*. The short fibers which are combed out are called *noyls*. See Fig. 1395.

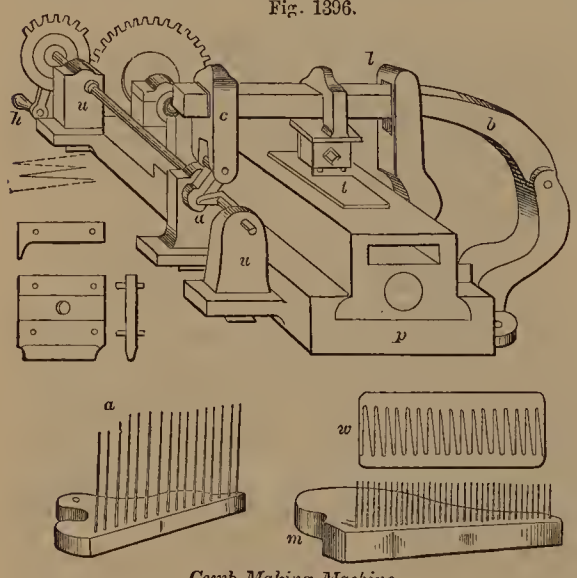
In *machine-combing*, the locks are fastened to two toothed cylinders which revolve in apposition to each other, and are heated by steam within. The teeth of one cylinder comb the fibers on the other one.

Comb-ma-chine'. Bundy's English patent, October, 1797, is the first comb-making machine on record. It consisted of a number of circular saws on a mandrel. The comb-blank is mounted on a carriage and advanced by a screw.

A mode of making combs with economy of material was invented by Ricketts, London, some years since, and has become common. A slip, a little wider than a comb, is placed in a machine which has a descending cutter of peculiar conformation adapted to cut through the tortoise-shell or horn by a series of tapering cuts which form the outlines of the teeth of a pair of combs, as in the figure (*w*), the teeth of one comb occupying the interdental spaces of the other.

Kelly's "Machine for making Parted Combs" has a bed-plate *p* which is secured by screws to a bench; from the bed-plate rise standards *u* which support an axle *a* turned by a winch *h*. On the axle is a crank which communicates motion by the collar *c* to

Fig. 1396.



Comb-Making Machine.

the arm *b*, to whose lower side the cutter is attached. As the bar works up and down in the guide *l*, the cutter makes its incisions in the tortoise-shell *t*, which is intermittingly moved so as to be advanced one notch between each descent of the cutter.

The cutter consists of two sharp blades of steel, diverging from each other so as to give the required taper to the tooth. Each blow cuts one tooth, and by severance leaves a tooth on the twin comb, the respective combs being *parted* by a slight pull when the cuts are all made.

In the sliding bed there is an opening into which a heated bar is put to keep the tortoise-shell warm and prevent its splitting.

The bed is advanced between each pulsation of the cutter by a feed-screw operated by a spur-wheel and a mutilated gear on the winch-shaft.

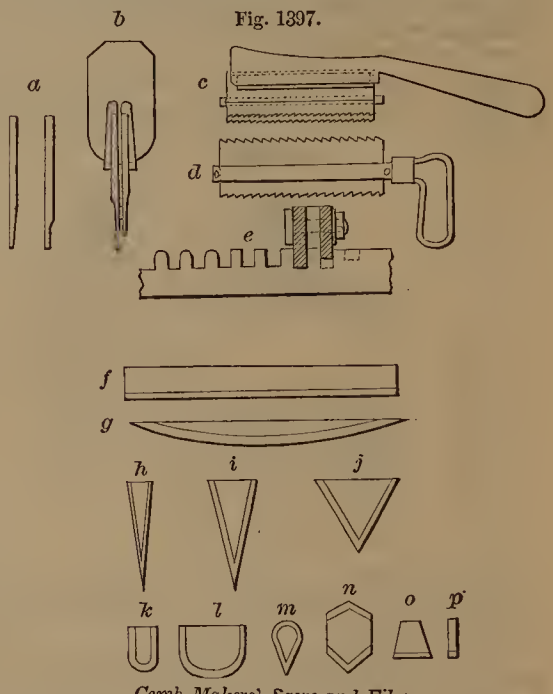
a m are brush-makers' combs. See p. 597.

Comb-pot. A stove at which the combs are warmed in the operation of preparing long-stapled wool for *worsted*.

Comb-saw. The hand-saw of the comb-cutter is called a *stadda*, and has two blades, one deeper than the other; a gage on the saw-blade determines the depth of cut. Some of the saws are serrated on each edge. The blades are made of thick steel, and are ground away on the edges as thin as the notches of the comb. They have about twenty points to the inch. Between the blades is a thin slip or tongue of metal, called a *languet*, which determines and preserves the interval. The arrangement of the two blades secures the regularity of the intervals, as the shallow tooth keeps in advance and sinks the tooth half-way, while the deeper tool completes the former kerf. The form and mode of action are shown at *a*, *b*, *c*, *d*, *e*, Fig. 1397.

The files of the comb-maker are called by specific

Fig. 1397.



Comb-Makers' Saws and Files.

names, mostly derived from the French, as are the operations. They are, —

f, the *float*; *g*, the *graille*; *h*, the *found*; *i*, the *carlet*; *j*, the *topper*.

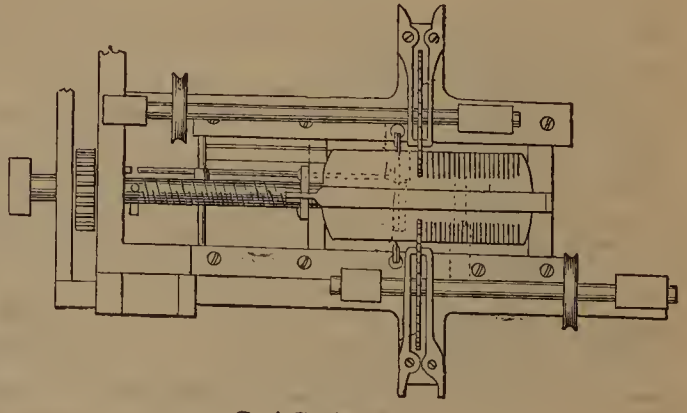
The files are of the description called *floats*; that is, they have but a single course of teeth, and incline forward at about 15°. The teeth are made by a file, as the shape is not readily obtained by chisel and hammer.

The floats *k l m n* are used by ivory-carvers for the handles of knives and in the preparation of works which are completed by scorpers and gravers.

o and *p* are used as inlaying tools.

In the comb-sawing machine (Fig. 1398) the carrier, with the stock from which the comb is produced, receives a succession of movements, each advancing the comb the distance of a tooth's width. The saws enter and recede in unison with these movements,

Fig. 1398.



Comb-Sawing Machine.

and the pointers cut nicks as starting-points for the saws, which act subsequently.

Com'et-seek'er. A cheap equatorial, with coarsely divided circles, and a large field in comparison to its aperture. Its name suggests its use, and the resultant "find" is subjected to the more accurately graduated and more powerful instruments of comparatively limited fields.

The *comet-seeker* of the Washington Observatory was made by Merz and Mahler, of Munich. It has an object-glass of about 4 inches in diameter and a focal length of 32 inches. Low powers are used, that it may embrace a large field and collect the greatest possible quantity of light. It cost $ 280.

Com-mand'er. 1. (*Nautical.*) A large wooden mallet, used in the sail and rigging lofts in driving the splicing-fid.

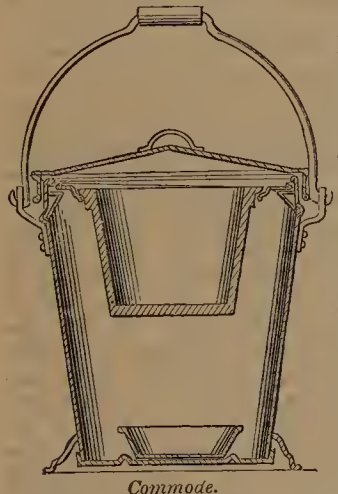
2. (*Hat-making.*) A string on the outside of the conical hat-body, pressed upon it down the sides of the block, to bring the body to the cylindrical form.

Com-menc'ing-ham'mer. The hammer of the gold-beater which he first uses after the *quartiers* are placed in a packet with interleaves of vellum. It weighs 6 or 7 pounds, and has a slightly convex face 4 inches in diameter.

Com'mis-sure. (*Masonry.*) The joint between two courses.

Com-mode'. A night closet containing a chamber vessel or urinal, with a lid and means for preventing exhalations of fetid odors. The commode has usually a seat, lid, and stench-tight joint. In the illustration, the covered pail has a pan for feces, and one for a disinfectant which deodorizes the mephitic vapors. See EARTH-CLOSET.

Fig. 1399.



Commode.

Com'mon Raf'ters. The upper rafters, holding the covering; in contradistinction to the *principal* rafters.

Com-mu'ni-ca'tion-valve. (*Steam.*) The valve in the steam-pipe leading from the boiler to the cylinder of a steam-engine.

Com'mu-ta'tor. (*Telegraphy.*) An instrument which periodically interrupts an electric current.

The word is generally used as a synonyme of *Rheotrope.*

Sometimes used (in England especially) as a name for a device for throwing into a circuit a greater or less amount of the force of a battery.

Occasionally used to designate a device for directing a current into several circuits in succession; the current being through only one circuit at a time.

It seems to be used in the above senses by various standard electricians, but they all agree in one point in their use of it; i. e. that there is *change*, either of direction, strength, or circuit of the current.

Com-pan'ion. A wooden covering over the staircase to a ship's cabin. A *companion-hatch.* The staircase is the *companion-ladder* or *companion-way.*

Com-par'a-teur. A Prussian instrument for accurately ascertaining the length of measures after Bessel's mode. The micrometers are placed on a strong mahogany beam; and the slide, which carries the two measures to be compared, is so arranged that it moves them exactly behind one another in the micrometer line, and there retains them.

Com'pass. 1. A circumscribing instrument, or one for describing arcs or measurer's lines.

2. An instrument for determining horizontal direction by reference to a poised magnetized needle. See —

Amplitude-compass.
Azimuth-compass.
Beam-compass.
Bisecting-dividers.
Bow-compass.
Bow-pen.
Bow-pencil.
Bullet-compass.
Calipers.
Circumferentor.
Circumventor.
Club-compass.
Compass-board.
Compass-brick.
Compass-card.
Compass-joint.
Compass-needle.
Compass-plane.
Compass-roof.
Compass-saw.
Compass-timber.
Compass-window.
Cone-compass.
Cutting-compass.
Diamond-cutter's compass.
Dipping-needle.
Dividers.
Double compass.
Drawing-compass.
Fluid-compass.
Hair-dividers.
Hanging-compass.
Lengthening-bar.
Magnetometer.
Mariner's compass.
Millwright's compass.
Musical compass.
Napier's compass.
Oval compass.
Pencil-compass.
Pillar-compass.
Plain compass.
Planchet.
Proportional compass.
Quadrant-compass.
Rack-compass.
Scribing-compass.
Self-registering compass.
Surveyor's compass.
Tell-tale compass.
Transit.
Triangular compass.
Tube-compass.
Universal compass.
Variation compass.
Volute compass.
Whole-and-half compass.
Wing-compass.

Com'pass-bar. A fixed iron ring in the *silver-from-lead-extracting furnace*, which supports the *test* or *cupel-hearth* in place in the reverberatory, where the process is carried on. See SILVER-FROM-LEAD-EXTRACTING FURNACE.

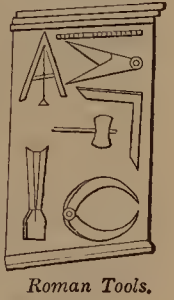
Com'pass-board. The *hole-board* of the loom for fancy weaving. It is an upright board of the loom through which pass the neck-twines.

Com'pass-brick. A brick with a curved face, suitable for wells and other circular work.

Com'pass-card. The card of a mariner's compass on which the points are drawn. It is usually attached to the needle, and is read with reference to a mark which represents the ship's head.

Com'pass-es. A two-legged instrument for measuring distances, or for describing arcs or circles.

Fig. 1400.



Roman Tools.

The compass was a common implement among the carpenters and masons of ancient times. The nonsense about its invention by Perdix, the nephew of Dædalus, and the consequent hurling from the temple of Athena by his envious uncle, is rather absurd, considering the condition of austral and oriental architecture for several thousand years then past. Nepoticide was common enough, however.

The cut is from a Roman tomb, and shows the compass, calipers, plumb, rule, square, mallet and chisel.

That the compass was known to the Egyptians cannot be doubted. It cannot be necessary to cite particular instances of its evident use in architecture and drawing. The tombs of Beni Hassan, about 1706 B. C., and Thebes, about 1500 B. C., are full of illustrations, both in their own construction and

their mural ornaments, of the uses of the compass. While the dates of the Egyptian monuments have not been ascertained beyond 2100 B. C., or thereabouts, all will admit that the monuments of Osymandyas were made by a nation that had been in process of development for many centuries. So the compass was in use in Egypt many hundred years before Cecrops and his brother Egyptians left their native country and gave the first taste of arts to ancient Attica.

Several compasses were discovered at Herculaneum (overwhelmed, A. D. 79), and among the number was a pair of reducing-compasses. See BOW-PEN ; DIVIDERS ; also list under COMPASS.

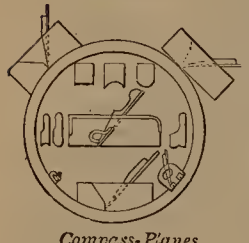
Com'pass-joint. A form of joint usual in compasses in which one leg has a circular disk or two, clamped between other disks belonging to the fellow leg.

Com'pass-nee'dle. The polarized bar which is suspended so as to assume a direction resulting from the earth's magnetism. There are several ways of suspending the needle. See MARINER'S COMPASS ; DIP-COMPASS ; MAGNETOMETER.

Com'pass of the Fig'ure 8. A double calipers, measuring with one pair of branches and giving the measure with the other. See CALIPERS.

Com'pass-plane. A plane with a curved face, used to work on concave surfaces. The illustration shows several forms, and also some *hollows and rounds* also compass-shaped. An ordinary smoothing-plane is also shown, whose sole is non-conformable to the surface under treatment.

Fig. 1401.

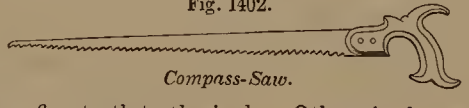


Compass-Planes.

Com'pass-roof. A bent rafter or curb roof.

Com'pass-saw. A saw with a narrow blade, adapted to run in a circle of moderate radius. By a rotation of the hand it is constantly swerved, and its *kerf* allows it some play, so that it cuts in a curve. It is usually thick enough on the cutting-edge to run without any *set*. The blade is an inch wide next to the handle, tapers to one quarter inch at the point,

Fig. 1402.



Compass-Saw.

and has five teeth to the inch. Otherwise known as a FRET-SAW ; LOCK-SAW ; KEY-HOLE SAW.

Com'pass-tim'ber. Naturally crooked, curved, or arched timber for ships' frames, to secure deck-beams to the frames, etc.

Com'pass-win'dow. (*Carpentry.*) A circular, bay, or oriel window.

Com'pen-sa'tion Bal'ance. A balance-wheel for a watch or chronometer, so constructed as to make isochronal beats, notwithstanding changes of temperature.

It was invented by Harrison, of Foulby, England, who devoted himself for a long series of years — 1728–1761 — to the discovery of a mode of overcoming the change of rate due to the expansion and contraction of the balance.

The *compensation pendulum* requires but one adjustment, to maintain the center of gravity at an equal distance at all times, from the axis of oscillation. The *compensation balance* is subject to two variations, — one owing to the expansion and contraction, by variations of heat, of the balance itself, causing it to go slower or faster as the case may be ; the other owing to the expansion and contraction of the *balance spring*, which is rendered more rigid by cold and less rigid when expanded by heat, thus exerting a variable effect under variations of temperature.

Harrison was the inventor of the *gridiron* compensation pendulum for clocks, which depends for its action upon the unequal expansion and contraction of different metals by given degrees of heat. In the search of a mode of giving an even rate to the balance-wheel of a watch, he first applied his combined steel and brass to the *curb* of the regulator, so that the spring became lengthened or shortened in a degree sufficient to compensate for its own change of tension, and also for the changed diameter of the balance.

The *curb* of the regulator has two pins which embrace the *hair-spring* or *recoil-spring* of the balance, and determine the length of the spring involved in the action. When a longer portion is allowed to play, the beat is slower, and conversely.

The English government in 1714 offered a reward of £20,000 for the discovery of a correct mode of ascertaining the longitude at sea. Harrison made four time-pieces within the years above cited, and in 1764 and following years received £24,000 for his improvements. (See CHRONOMETER.) The special point of novelty was the compensation balance, which was constructed to run at an equal rate under changes of temperature. It is formed of two metals, in the following manner : — (For illustration, see CHRONOMETER.)

A ring of steel is made with a bar across the middle ; outside this ring is a ring of brass, firmly brazed to it ; both rings are cut through at points diagonally opposite each other on opposite sides of the cross-bar, and a few screws with heavy heads are set in various places near the end of each portion of the cut ring ; consequently, as the elasticity of the chronometer spring is diminished, and the size of the balance itself is increased, by an increase of temperature, the outer brass ring of the balance is expanded more than the inner, steel one, bending the ends of the two combined rings, with their attached screws, inward, toward the center of gravity of the balance, and causing it to make an equal number of pulsations with a lesser force ; the object being to so compensate the decreased force of the spring by the decreased inertia of the balance, that the number of its vibrations shall be equal under all variations of temperature ; the balance compensating for its own contraction and expansion, and for inequalities in the effectiveness of the balance-spring. The peripheral contraction or expansion under increment or decrement of temperature, respectively, is due to the unequal expansion or contraction of the metals, steel and brass, under changes of temperature ; the same differential expansion or contraction that would cause them, if brazed together so as to be straight at a given temperature, to bend in one direction or the other when exposed to an atmosphere above or below that temperature.

The proper adjustment of the screws is a matter of great importance, requiring much nicety ; it being necessary to make repeated trials at different temperatures, and can therefore only be done in winter or by means of freezing mixtures ; thus rendering this compensation a tedious as well as expensive operation. The ultimate tests and rating are usually performed at government observatories.

Com'pen-sa'tion Pend'u-lum. A pendulum so arranged as to preserve the center of gravity of the *bob* at a constant distance from the axis of suspension, notwithstanding changes of temperature.

The principal compensating pendulums are, —

The gridiron, by Harrison.

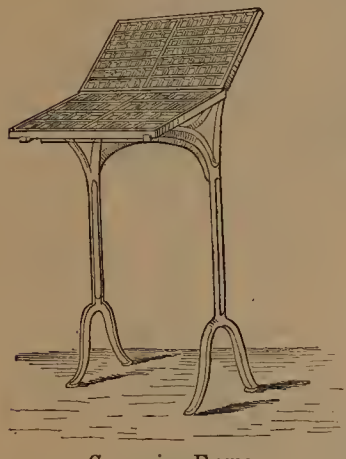
The mercurial, by Graham. See PENDULUM.

Com'pen-sa'tor. 1. (*Nautical.*) An iron plate placed near the compass on board iron vessels, to neutralize the effect of the local attraction upon the needle.

2. (*Gas.*) A device to equalize the action of the exhauster which withdraws the gas from the retorts. Should the exhauster be driven so fast as to reduce the pressure on the retorts below the desired point, the diminished pressure will act upon the elastic plate and cause the motion of a valve which allows the gas to pass back towards the retorts. The compensating device is similar to that of a gas-regulator, but the application is special for the purpose stated.

Com'po. A concrete or mortar.

Fig. 1403.



Composing-Frame.

Com-pos'ing-frame. The stand on which the printer's cases rest.

Com-pos'ing-ma-chine'. A machine in which type are set up. See TYPE-SETTING MACHINE.

Com-pos'ing-stand. A frame holding the printer's cases. (Fig. 1403.) See CASE.

Com-pos'ing-stick. A metallic frame to contain type, with one open side and one adjustable end, which is moved out or in to adapt it to the width of a column. In it the type are composed

Fig. 1404.

Composing-Stick.

and justified, and from it they are transferred to the *galley*.

Com-pos'ite. (*Shipbuilding.*) A vessel having a wooden skin on an iron frame-work. Jordan's system, English patent, 1849, is as follows: —

The whole outer skin, including keel, stern, stern-post, and planking, is of wood, arranged as in the skin of an ordinary wooden ship; and the frame-work inside the skin, including frames, beams, keelson, stringers, shelf-pieces, water-ways, hooks, transoms, diagonal braces, etc., is of iron, arranged nearly as in an ordinary iron ship. Tables of rules for sizes of the different parts are given in the appendix to the third division of the folio work on "Shipbuilding," by Messrs. Watt, Rankin, Barnes, and Napier. Mackenzie, London, 1866.

Certain variations are found in composite building.

Bettely introduced trough-shaped or "channel iron" for the frames.

MacLaine's system consists of an inner skin of iron and outer skin of wood, on an ordinary iron frame.

Heni's system: an inner skin of iron to which are riveted transverse iron frames of a Z-shaped section. The angles of these frames are filled up solid with wood, and an outer wooden skin covers the whole.

Captain Skinner's system: an iron frame imbedded between two wooden skins.

Feather's system: wooden bottom and iron topsides. The iron frames terminate at their lower ends in broad forks or saddles, which sit upon and are fastened to the wooden parts of the sides.

Com-pos'i-tor. See TYPE-SETTING MACHINE.

Com'pound Arch. An arch which has the archivolt molded or formed into a series of square recesses and angles, and practically consisting of a number of concentric archways successively placed within and behind each other.

Com'pound ax'le. One consisting of two parts joined by a sleeve or other locking device. See AXLE.

Com'pound Bat'ter-y. A Voltaic battery, consisting of several pairs of plates, developing a cumulative effect. See GALVANIC BATTERY.

Com'pound Mi'cro-scope. A microscope made up of a combination of lenses arranged in a tube. See MICROSCOPE.

Com'pound Pier. A clustered column.

Com'pound Rail. A rail made of several portions with a longitudinal joint, avoiding the transverse joint across the rail whereby the jarring is occasioned. A *continuous rail.*

The term may also be applied to several forms of rails which consist of a number of portions bolted or keyed together.

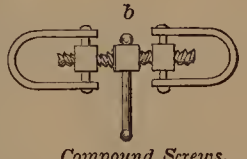
Com'pound Rest. (*Lathe.*) The tool-carrier of an engine-lathe, moved longitudinally (along the work) by the *leading-screw*, actuated by the feed; and transversely (to or from the work), by its own feed-screw.

Com'pound Screw. Two or more screws on the same axis. When the pitch of the respective screws varies, it forms a differential screw (*a*); when they run in different directions, it is a right and left screw (*b*).

Fig. 1405.

a

b



Compound Screws.

Com'pound Steam-en'gine. (*Steam.*) A form of steam-engine originally patented by Hornblower in 1781, in which steam at a relatively greater pressure was allowed to expand in a small cylinder, and then, escaping into a larger cylinder, to expand itself against a larger piston. As steam was applied in his day at so very small a pressure, the particular value of the idea was not developed until Trevethick and Woolf used a high pressure in the first cylinder with expansion into a larger one.

Trevethick applied high-pressure steam to Watt's ordinary single cylinder or Cornish engine, while Woolf revived and modified Hornblower's engine, and, by working it with high-pressure steam, obtained results far beyond those of the original inventor. Woolf's first engine was erected at Meux's brewery in 1806. He took up his residence in Cornwall about 1813, where he astonished the Cornish engineers with the results obtained, but ultimately they found that high-pressure steam, applied to the single-cylinder engines, produced equally good results at the ordinary pressures when used expansively.

Compound engines are of two classes, which may be called combined and independent compound engines. The former are those in which the cylinders are near each other, and the pistons commence their respective strokes simultaneously or nearly so, the steam expanding from one cylinder direct to the other through as small a passage as convenient. To this class belong most land engines, and the compound marine with cranks at about 130°. In inde-

pendent compound engines, the cylinders need not be near, and the pistons need not — generally do not — make their strokes together; their distinctive feature being that the steam passes from one cylinder to a receptacle which may be as large as convenient, and that from this the large cylinder takes its steam. To this class belong many condensing land engines, furnished with auxiliary high-pressure cylinders, and the compound marine engines with cranks at right angles. See DOUBLE-CYLINDER STEAM-ENGINE; DUPLEX STEAM-ENGINE.

Com'press. 1. A pledget of tow, folded linen, or lint, to press upon any part to stop bleeding, arrest circulation, or for other purpose.

2. A machine for re-pressing cotton bales.

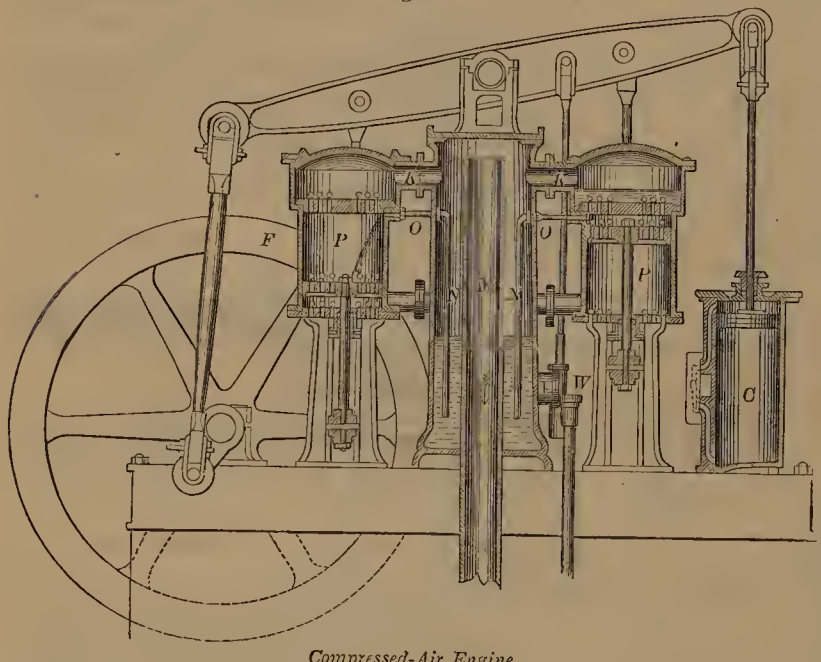
Com-pressed'-air En'gine. One driven by the elastic force of compressed air. Its construction is usually like that of a steam-engine, the force of the expanding air being exerted against a piston in a cylinder.

An air-compressing machine for the service of such an engine was built, previously to 1856, by Randolph, Eliot, & Co., of Glasgow, Scotland, for Govan Colliery, near that city, and was described in the proceedings of the Institution of Mechanical Engineers at Glasgow. It was used to condense air to work an ordinary high-pressure engine at the lower shaft of the mine. It was held by those who were familiar with the construction and working of the engines, that a more valuable effect would have resulted from working the air expansively, cutting off at one third stroke and expanding down to the atmospheric pressure. A valuable feature developed in this connection was the low temperature of the escaping and expanding air, which was very salubrious in a mine whose temperature varied from 80° to 90° F. The apparatus had been in use six years without requiring any repair beyond the replacement of some of the valve-cages.

The air-main was of the area of the working cylinder, and the difference in pressure at the two engines was only one pound in favor of the upper one.

Fig. 1406 is a vertical section of the compressing engine, in which the steam-cylinder *C* is 15 inches in diameter, with a stroke of 3 feet; it drives two condensing air-pumps *P P* which work alternately, one on each side of the beam center, delivering the air into the center reservoir *N N*, from which it passes into the main pipe *M*. The beam is connected at the other end to a crank and fly-wheel *F*, for the purpose of equalizing the motion.

Fig. 1406



Compressed-Air Engine.

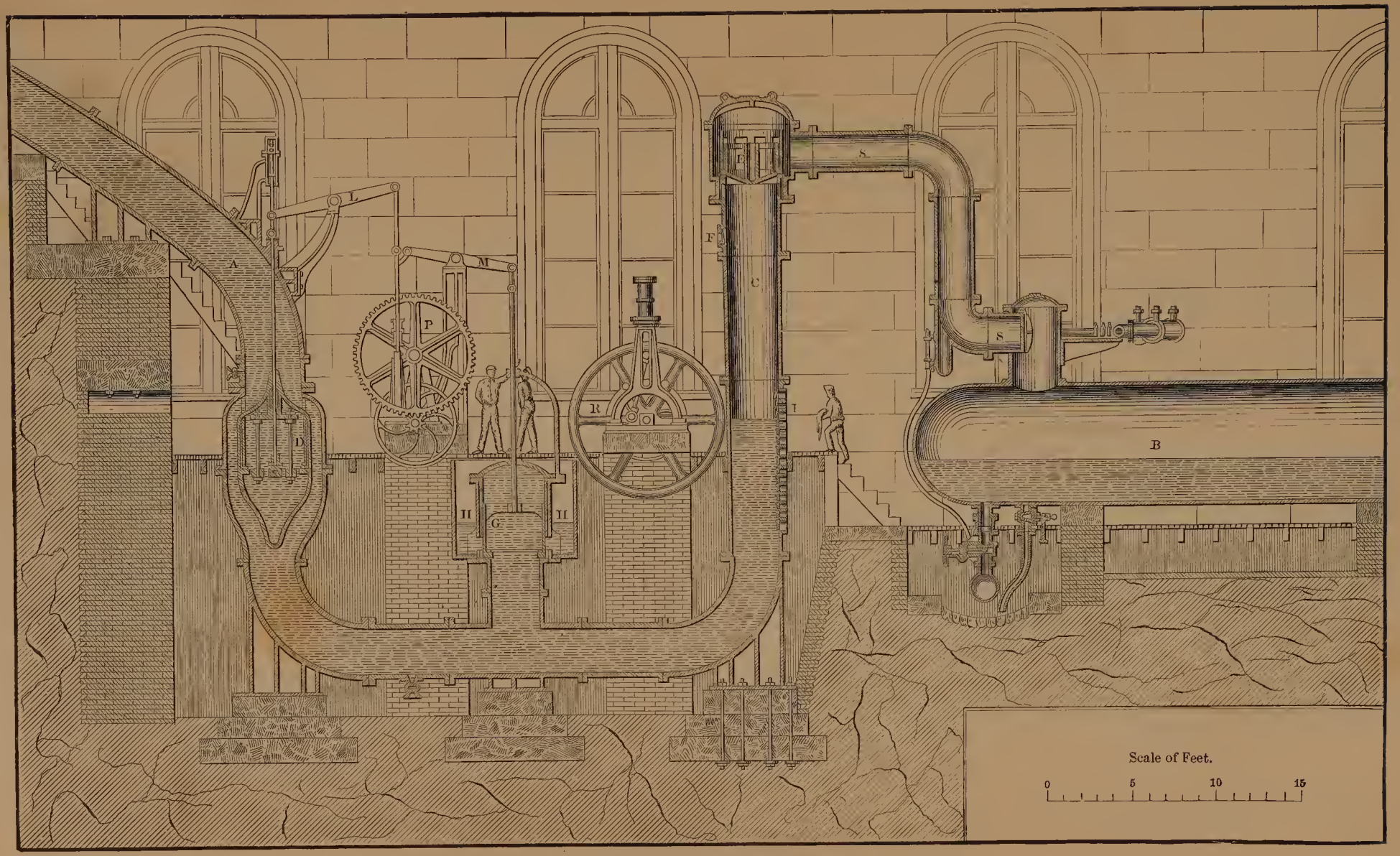
The air-pumps *P P* are 21 inches in diameter, with a stroke of 18 inches; they are placed inverted, with the piston-rods passing out below, where the stuffing-boxes are not exposed to the pressure of the compressed air, and are worked with cross-heads, sliding in vertical guides by means of side rods from the beam. The air-pumps are fitted with ball-valves, of which there are three sets to each pump, each set consisting of 44 brass balls, 2 inches in diameter, arranged in three concentric rings. The balls are confined by separate cages to a lift of $\frac{1}{2}$ inch. A stratum of water supplied by a pump *W* covers the piston valves, and the delivery and inlet valves, through which all the air has to pass. The water flows from the central reservoir through the small pipes *O O* into each of the air-pumps during the periods of their downward strokes. The surplus water is discharged at each upward stroke through the delivery valves, keeping them also covered with water.

The compressed-air engine at Ardsley Colliery, England, travels upon wheels and is pushed to its work by hand. A steam-engine at the surface compresses air to a pressure of from 50 to 60 pounds to the square inch, and the air is conveyed by metallic tubes to the bottom of the mine, and by a caoutchouc tube to the engine. It undercuts 3 feet deep and 150 feet long in 8 hours.

One of the Mount Cenis Tunnel air-compressors, invented and constructed by Sommeillenr, and placed at Bardonneche, the Italian end of the tunnel, is represented by a vertical longitudinal section on the page opposite. The description is condensed from the report of Dr. F. A. P. Barnard, United States Commissioner to the Paris Exposition.

The compressors operate by applying the living force of a large column of water descending in an inclined tube *A*, to drive a body of confined air into a receiver *B*, within which there is maintained a constant pressure of six atmospheres by means of an hydraulic head. Each compressing-engine is an inverted siphon, having the long arm *A* inclined and the short arm *C* vertical. The puppet-valve *D* is for the purpose of regulating the periods of motion and rest of the contained water column.

The short arm *C* of the siphon is the chamber into which is introduced the air to be compressed. At its upper extremity it communicates by a valve *E* with the receiver *B* of compressed air. This valve is kept closed by the pressure of the air in the receiver, so long as the pressure beneath it is less, but when the air beneath attains by compression the same tension as that already in the receiver, the valve opens and the new charge enters.



SOMMEILLEUR'S AIR-COMPRESSOR.

BARDONNECHE, MT. CENIS TUNNEL.

PLATE X.

See page 602.

The compression-chamber *C* receives its successive charges of air from the atmosphere by valves *F* opening inward. It is freed from water after each pulsation or act of compression, by means of another valve *G*, which opens at a level somewhat above the bend of the siphon, so that the bend itself and the long arm remain always full of water, the overflow at *F* being discharged through the canal *H*.

The action of the machine is as follows: — The air-chamber *C* being full of air at the ordinary density of the atmosphere, the great valve *D* in the inclined pipe *A* is opened, and the water rushes through the short bend into the chamber *C*, compressing the air before it, and finally driving it through pipe *S* into the receiver *B*. The water then comes to rest, the supply valve *D* closes, the discharge valve *G* opens, the water escapes at *H*, and a new charge of air enters at *F*.

L is the motive lever of the feed-valve, *M* the motive lever of the discharging-valve. *P* is the gearing by which the proper correspondence of motion between the respective valves is secured. *R* is the engine which operates the gearing *P*, and intermediately the valves *D G*.

The difference of level between the head of the driving column of water and the point of discharge is 85.25 feet. The diameter of the tube is 23.56 inches, and the hight of the air-chamber, measured from the level of discharge at bottom to the valve opening into the recipient at top, is 47.12 inches. These measurements would give for the total capacity of the air-chamber 39.9 cubic feet; and this is the maximum charge which the machine is capable of compressing at a single impulse. The charge actually compressed, however, is less than this, and is determined by the condition that the resistance which it opposes to the driving force, during its compression and subsequent passage into the recipient, shall exhaust this force exactly, without excess or deficiency. In case the resistance is in excess, a portion of the air will fail to pass into the receiver and so be lost. In case it is in deficiency, a portion of the motive-power will be uselessly expended, and, moreover, the column of water will strike the top of the air-chamber with violence, and may damage the machine. The practical adjustment of the bulk of the charge to the power of the engine is attained by a tentative process, a series of small valves *I* being adapted to the side of the air-chamber in a vertical row, through which the air can escape, but which the air by its inertia closes successively as it rises. If, in a series of experiments, these valves be secured one after another, beginning at the top, the charge of air will be gradually increased, until at length it is found to have the volume required.

There were at Bardonneche ten of these compressors constantly at work, each one making three impulses per minute, or 4,320 per day. If the charge at each impulse were equal to the capacity of the air-chamber, the total volume of air compressed daily would be 1,723,204 cubic feet. It appears that the volume actually compressed amounted to only 826,020 cubic feet, so that the charge in the compressor was but about 19 cubic feet at each impulse.

The power of such a compression machine is equivalent to that which would be generated by the descent of a vertical column of water 85.25 feet in length and 23.56 inches in diameter through a space of 47.12 inches three times per minute through the day. The calculation shows that this would a little exceed 18-horse power. The whole ten of the compressors furnished, accordingly, 180-horse power.

The power employed is actually capable of compressing 1,195,258 cubic feet daily, to a bulk under the pressure of six atmospheres of 305,350 cubic feet, becoming by subsequent contraction 201,210 cubic feet. But the amount actually compressed was only 826,020 cubic feet daily, giving ultimately 137,670 cubic feet of compressed air at the normal temperature. This represents a compressing force of only 125-horse power, being less by 55 than the theoretic force of the compressors.

The 137,670 cubic feet at the pressure of six atmospheres are capable of producing an amount of work hardly equivalent to 75-horse power. There was therefore a loss at Bardonneche, from causes known and unknown, equal to seven twelfths of the hydraulic force employed.

The same hydraulic power, or an equivalent steam power, would probably be applied more effectually in compressing air by means of pumps, than in the method above described. This the engineers themselves appear to have tacitly admitted, by introducing pumps at the northern entrance of the tunnel.

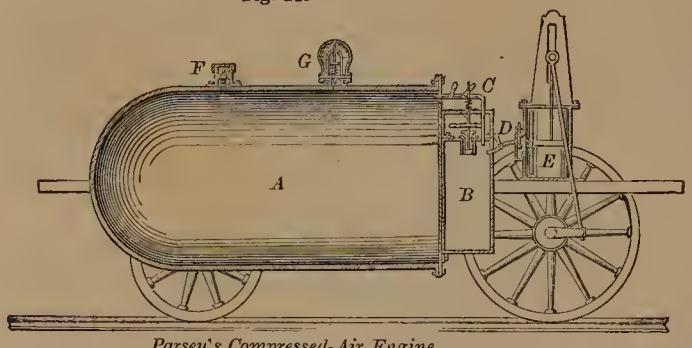
The success of the Mont Cenis tunnel and the progress of the Hoosac have settled the question of the availability and economy of the system of transmission of compressed air by pipes. The cooling and ventilation, as has been already remarked, are important auxiliaries. The Hoosac Mountain is being daily pierced at either end about five feet, by means of rock drills, using compressed air as a motor. The practice at Mont Cenis carried air at 50, 60, and 70 pounds to the square inch 4 miles in pipes of 8 and 10 inches diameter, and at Hoosac tunnel, Massachusetts, air was carried at 60 and 65 pounds to the square inch $1\frac{3}{4}$ miles with little or no loss. There are other instances of long conducts, in pipes from 1 inch to 8, 9, and 10 inches. Near Mauch Chunk, Pennsylvania, a railroad tunnel is being driven, or has been completed, under a mountain by the same agency.

The piers for Roebling's East River Bridge, and those for Eads's Illinois and St. Louis, are sunk by the aid of compressed air conveyed in tubes.

Locomotives have been driven by means of air compressed into reservoirs, and are briefly referred to in the article on AIR-ENGINE. One of these was invented by BOMPAS (English patent, 1828). On the frame of the locomotive were two tanks which were charged with compressed air by stationary engines at the depots and way-stations. The air operation was substantially similar to that of a steam-engine, the air being admitted from alternate reservoirs to the sides of the pistons with which the said reservoirs respectively communicate. The piston-rod is connected in the usual manner with the crank and driving-shaft. An engine, similar in most material respects to the above, was made by Baron von Rathlen, in 1848, and was driven by its air motor from Putney to Wandsworth (England), at the rate of ten or twelve miles per hour.

PARSEY, in 1847, invented an engine of this character in which a large reservoir *A* was secured to a frame mounted on wheels. In this reservoir the air was compressed to as great an extent as was compatible with safety, and was emitted gradually into the chamber *B*, where it expanded to its working pressure. This emission is regulated automatically by a plunger in a tube passing through the roof of the chamber *B*. Above the plunger is a spring which yields to the normal or working pressure of the air in the chamber *B*; but when, owing to the withdrawal of air to the working cylinder, the pressure in the chamber is relaxed, the spring depresses the plunger

Fig. 1407.



Parsey's Compressed-Air Engine.

and the connections of the latter turn a faucet-valve in the pipe *C*, and allow the passage of air from the reservoir *A* to the chamber *B*, to restore the working pressure in the latter. The compressed air passes by the pipe *D* to the cylinder *E*, where it acts in the manner usual with the double-acting steam-engine, and exhausts into the atmosphere. *F* is the supply aperture through which the reservoir is charged, and *G* the safety-valve. The piston-rod, cross-head, and pitman connect in the usual way with the crank and driving-shaft.

The project has lately been revived for impelling street-cars.

Under "Air as a Means of Transmitting Power," has been noticed the attempt of Dr. Papin of Blois to run a pumping-engine by compressed air conducted by pipes from a condensing engine situated at the distance of a mile and driven by a fall of water. For some reason, friction and leakage probably, the doctor failed.

For the application of compressed air as a water elevator, see "Air as Water Elevator, Compressed."

In the city of New York, in 1858 or 1859, Captain Ericsson arranged a power to run sewing-machines for a clothing firm in that city. A caloric engine in the cellar compressed the air; it was carried to the upper story in pipes, and there moved little engines, which, in turn, operated sewing-machines to the number of some eighty. The act of compressing air throws off its heat, and then when it is again exhausted, it takes up that heat again from the surrounding atmosphere, doing two things, condensing and precipitating the vitiated air, and furnishing one of the best possible means of ventilation. These machines worked successfully for years.

H. H. Day now proposes to transfer the power of the Niagara Falls to Buffalo, minus certain admitted losses in working, which would leave a handsome surplus. Also the lower falls at Rochester, N. Y., to that city. *Nous verrons.*

Com-press'ing-ma-chine'. A machine for making compressed bullets.

Com-pres'sion-cast'ing. A mode of casting bronzes, etc., in molds of potters' clay under a pressure which causes the metal to flow into the delicate tracery left by the pattern. The work approaches nearly the work of the graver and chisel. It is especially used in casting house-builders' hardware, letters and numbers for houses, stamps, etc.

Com-pres'sion-cock. One containing an india-rubber tube which is collapsed by the pressure of the end of a screw-plug turned by the key.

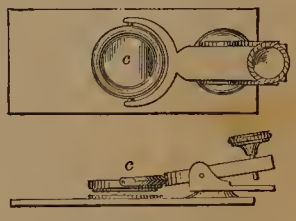
Com-press'or. 1. (*Surgical.*) An instrument to compress the femoral artery; a substitute for a tourniquet.

2. (*Nautical.*) *a.* A lever arm to press on the chain-cable and keep it from veering away too fast.

b. A device for compressing a gun-carriage to its slide or platform during recoil; the carriage is again set free for running up.

3. (*Mieroscopy.*) A device to flatten microscopic objects under examination,

Fig. 1408.



Lever-Compressors.

in order to make out their structure. The ring *c* and the base-piece beneath it are glazed, and, while not obstructing the light, form surfaces between which the object is flattened, or merely held. A compressorium.

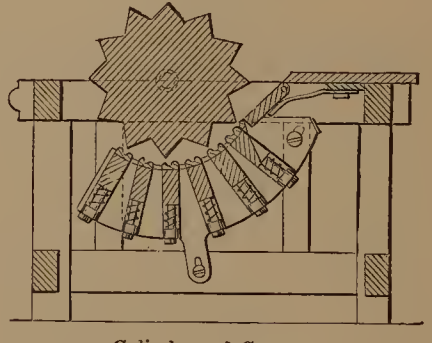
Compressors for the microscope are of various kinds; as, *lever, reversible cell, parallel plate, Wenham's*, etc.

4. (*Pneumatics.*) A machine for compressing air. See Air-pump; Compressed-air Engine; Air-compressing Machine.

Com'rade-bat'ter-y. One of a pair of *joint batteries.*

Con'cave. The curved bed or breasting in which a cylinder works, as in the case of a thrasher. Fig. 1409, the example, shows a concave in which each

Fig 1409.



Cylinder and Concave.

slat rests upon a spring, and the grain escapes through the intervening spaces.

Con'cave Brick. A brick used in turning arches or curves. A *compass*-brick.

Con'cave Plane. A compass-plane for smoothing curved surfaces.

Con-ca'vo-con'vex File. A file with curved faces, respectively concave and convex, made by cutting a flat file and then bending it into shape between dies. The mode is the invention of Sir John Robison, President of the Scottish Society of Arts, and is designed to enable the convex side to be cut like a flat file by a chisel which reaches across the edge, instead of by cutting numerous courses, which usually cover the convex surfaces of files.

Con-ca'vo-con'vex Lens. A lens whose sides are respectively concave and convex, the latter face having a curve of the greater radius, so that the lens is thicker at the margin than elsewhere.

It differs from a *meniscus* in that the concave face of the latter has the larger radius, and the margin is an edge where the two faces run together.

Con'cen-tra'tor. An apparatus for the separa-

tion of dry, comminuted ore, according to the gravity of its particles, by exposing a falling sheet of ore-dust to intermittent puffs of air. The action has been compared to that of the jigger which acts in a water-cistern, the body of ore in the sieve being jerked up and down in the water, and thereby separated into strata of varying gravities and consequent richness. The analogy is not perfect, for in the *jigger* the ores all lie in the sieve, but the upper layer is poor and is raked off as refuse, while the succeeding layers are progressively richer down to the best at the bottom, the different grades being scraped off in succession, and either reworked or laid aside for smelting, as the case may be.

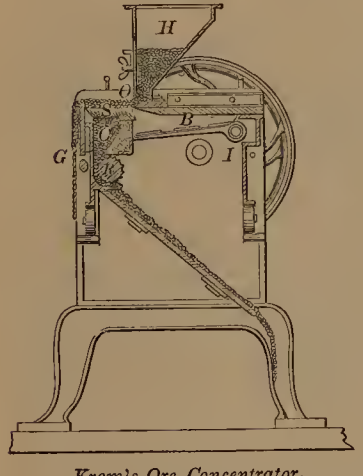
The action of Krom's concentrator is more like that of a fanning-mill, in which the richer portions (the grain) withstand the blast and fall into the receiver, while the lighter portions, which have but few metallic particles, are blown over and correspond to the tailings of the grain-winnowing machine.

A form of concentrator analogous to the smut-mills might be contrived, the ore passing through a trunk, the lighter being carried the farthest, a separation into grades of comparative gravity being thus effected.

Krom's concentrator has an arrangement in which the ore passes from a hopper on to a sieve, upon which it forms a bed. This bed of ore is intermittingly lifted by a pulsating blast beneath, so that it becomes sorted into layers of comparative gravities. The upper is the lighter portion or refuse, and falls over the end of the sieve as tailings; the heavier portion passes through the meshes of the sieve, and is collected in a receptacle beneath.

In the comparison between the *jigger* and the *concentrator*, it will be found that in the heavier medium, water, the material will sink slowly, and thus the particles will tend to sort themselves effectually. In the *concentrator*, the medium being lighter, the ore will fall more quickly. As it is necessary that the ore, between each pulsation, either in the *jigger* or in the *concentrator*, shall have time to fall again on to the sieve after each saltation, the ore in the *concentrator* may be more rapidly pulsated than it can be in the *jigger*.

Fig. 1419.



Krom's Ore-Concentrator.

Water is said to admit of from 50 to 80 lifts per minute, and air from 300 to 400 in the same space of time. Whether the more rapid action in air be more effectual than the more perfect suspension and gradual subsidence in water, is a matter to be determined by experiment and persistent trial. It is not safe to argue the question on general grounds.

The machine has a receiver *H* to hold the pulverized ore; an ore-bed *S* on which the ore is acted upon; the gates *O G* to regulate the flow of ore from the receiver and depth of ore on the ore-bed; passage *C* for the ore; and roller *R* to effect the discharge of the same; bellows *B* to give the puffs of air; a trip-wheel and spring to operate the bellows; a ratchet-wheel and pawl to operate the discharge-roller *R*.

It is operated as follows: — Ore is placed in the receiver *H*, and the driving pulley set in motion. On the opposite end of the pulley-shaft is the trip-wheel, which acts against a lever; by the joint action of the trip-wheel forcing the lever in one direction and the spring carrying it suddenly back in the opposite one, the bellows *B* is made to swing on the shaft *I*, giving at each upward movement a sudden puff of air through the ore-bed, and lifting the ore lying on it.

The spring is adapted to produce the best result, as it is important that the puff of air should be sudden. On the trip-wheel are six projections; therefore the speed of 50 to 70 revolutions per minute of the pulley gives 300 to 400 upward movements of the bellows.

Other forms of concentrators for comminuted ore, amalgam, auriferous sand, and sulphurets consist of agitated pans, reciprocated or revolving in a rotary path, and having inclined beds over which the material is sorted by gravity and discharged at different outlets.

Con-cen'tric En'gine. One name for the rotary engine (which see).

Con'cer-ti'na. An instrument with a bellows and free reeds, on the principle of the accordion. It is grasped by both hands, and the keys are on each of the heads. An instrument of sweetness, power, and compass. Invented by Professor Wheatstone.

Con'cha. (*Architecture.*) The concave, ribless surface of a vault.

Con-chom'e-ter. An instrument for measuring shells. *Conchylcometer.*

Con-clud'ing Line. (*Nautical*). *a.* A small line hitched to the middle of the steps or stern-ladders.

b. A line leading through the middle of the steps of a Jacob's ladder.

Con-crete'. A mixture of rubber, stone chippings, gravel or broken stones, with lime and water. It is used in foundations and in filling in between masonry facings of walls. It differs from pisé material in having lime instead of clay to form a bond for the stones. See PISÉ-WORK; BÉTON.

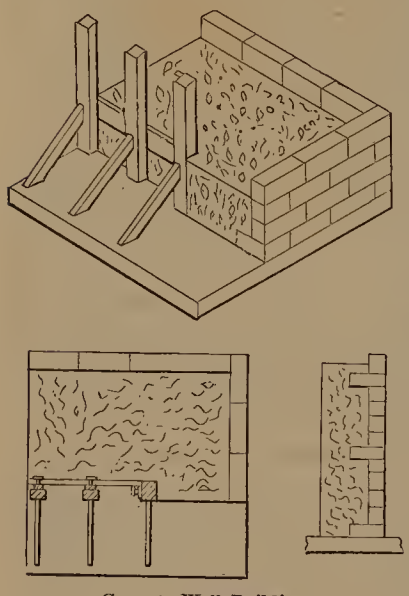
The ancients used concrete very largely. In wall building, it is usually made by dumping the materials into the trench dug for the foundation, the gravel, sand, lime, and water being thrown in, in proper quantity; or the materials are measured into a barrow, into which water is poured, and the whole dumped into the hole or trench where it is required. The proportions of sand and lime are those suitable for forming mortar. The mortar forms a bond for the larger stone, constituting a matrix of hydrated silicate of lime.

To guard against the filling up of the Saïd end of the Suez Canal by the deposits of the Nile, great blocks weighing twenty tons each, of a composite stone, formed out of hydraulic lime ground to dust by powerful mills, and mixed with sand, are sunk and piled in the harbor, and piers constructed thereon. Three hundred thousand tons of these blocks have been used at Port Saïd alone. See BÉTON.

The walls of the fortress of Ciudad Rodrigo, in Spain, are of concrete. The marks of the boards which retained the semi-fluid matter in their construction are everywhere perfectly visible; and besides sand and gravel, there are large quantities of round bowlder-stones in the walls, from 4 to 6 inches in diameter, procured from the ground around the city, where they abound.

Schroder's cement: coal-ashes, 100; hydraulic cement, 16; Portland cement, 1 part. Work in a pug-mill and mold. Cooley's: coarse pebbles, 60; rough sand, 25; lime, 15. Semple: pebbles, 80; rough sand, 40; lime, 10.

Fig. 1411.

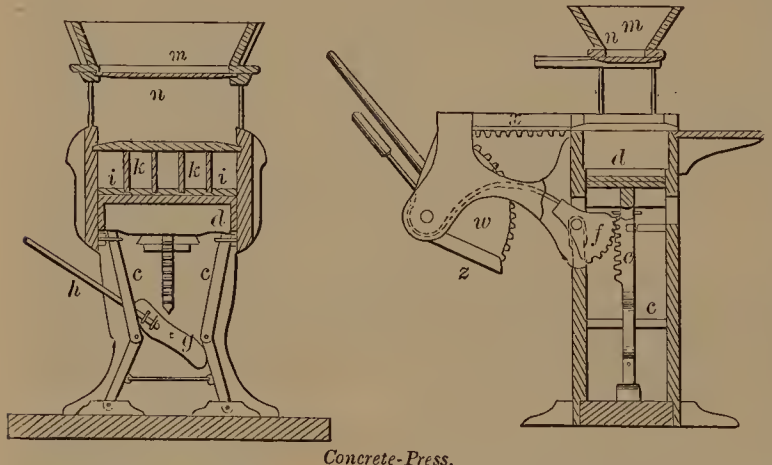


Concrete-Wall Building.

The mode of building concrete walls is indicated by the cut, in which the mass of mortar is held between facing walls of brick and inner boards, the latter being temporary.

Con-crete'-press. A machine in which a mass of concrete is pressed into the form of a building block. The concrete is placed in the hopper *m*, and, when the slide *n* and the lower slide are withdrawn, drops into the box, which has divisional partitions *k k* and a bottom *i*. The slide is replaced by the motion of the sector *w*, which moves the rack *x*. The pressure is then brought beneath the follower *d* by means of the lever *h*, cam *g*, and toggles *c e*. The lid of the press-box is then withdrawn, and the block is lifted out of the box by the sector and rack *f e*.

Fig. 1412.

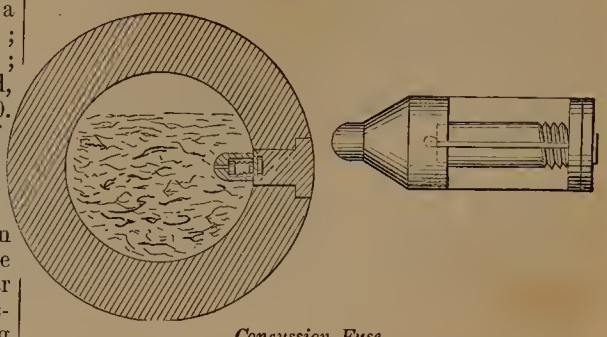


Concrete-Press.

Con-cret'er. A form of apparatus for concentrating sirup, by allowing it to flow in a boiling condition over the surface of a heated pan, and then subjecting it to the heat of a copper cylinder revolving over a fire, and having an internal hot-blast. The sirup in a concentrated condition is discharged at the lower end.

Con-cus'sion-fuse. A fuse which is ignited and explodes the shell at the moment of impact, by the breakage of a capsule or other similar internal arrangement, containing chemicals which explode by the force of the blow. The figure shows a spherical and an elongated projectile provided with a fuse which is exploded by the jar of impact.

Fig. 1413.



Concussion-Fuse.

Con-densed'-let'ter. (*Printing.*) One with a narrower face than usual with the given hight.

Con-dens'er. An apparatus for *cooling* heated vapors to a temperature at which they become liquid; or, fumes to a temperature at which they are precipitated; or, impure and heated gases to a more cleanly and cool condition; or, a heated vegetable extract or juice to a less fluid condition.

Or by *pressure*, bringing a sliver or film of fiber to a slightly felted and more solid condition; or, a foil to a more compact state; or, an elastic fluid into a smaller bulk.

Or, by convergence concentrating the heat and light of a pencil of rays upon a relatively small area.

Or, a means of absorbing minute electrical effects.

1. (*Steam-engine.*) A means of reducing to a liquid form the steam in front of the piston so as to obtain a partial vacuum at that point, and thus utilize the natural pressure of the atmosphere.

Steam-engine condensers are of several forms: —

The injection *condenser* was invented by Watt, who was a philosophical-instrument maker in Glasgow, when, in 1764, a model of an atmospheric engine (Newcomen's), belonging to the University of Glasgow, was brought to him to repair; the cylinder of this model was 2 inches in diameter, and 6 inches in length. Having repaired damages, whatever they were, the little machine was put to the proof, but failed to work satisfactorily.

He made a working machine on a larger scale, the cylinder being 6 inches diameter, 12-inch stroke, and was made of wood boiled in linseed-oil. Still the little machine was obdurate, and he failed to realize the results he supposed attainable.

The engine working on the atmospheric principle, the valuable effect was in proportion to the perfection of the vacuum obtainable below the piston. But here a trouble met him. If he injected so large a quantity of water as to obtain a good atmospheric pressure, the cylinder was so much cooled that he lost a great quantity of steam in warming it up, and it became necessary to strike a mean. Smeaton, who had probably obtained the best results up to this time, rarely cooled the contents of the cylinder below 180°, at which temperature the steam has a pressure equal to a column of 15 inches of mercury. Thus he lost half the atmospheric pressure for the sake of avoiding the great waste of incoming steam

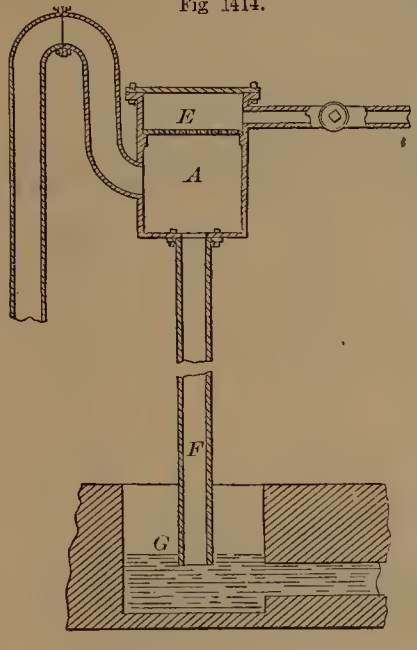
which condensed against the sides of the cylinder until the latter acquired the heat of the steam, all which was necessary before the engine could make the up-stroke.

Watt instituted a series of very careful experiments on the relation between temperatures and pressure of steam, and brought to bear upon the subject careful analysis as well as genius. The result was the *separate condenser*. Instead of cooling the cylinder, he connected it with another vessel in which the refrigeration was accomplished, a valved communication being provided between the two.

The engine was thus the atmospheric engine with a separate condenser, securing economy of fuel and time with increase of power.

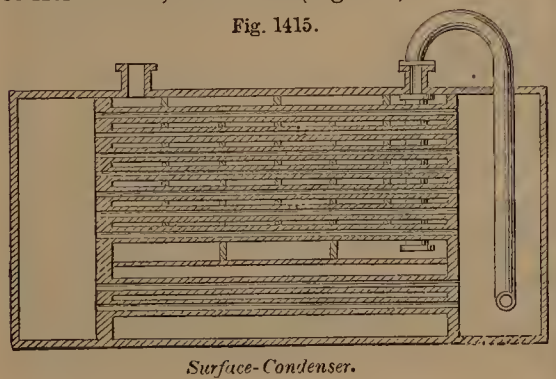
If the inventor had stopped at this point he would have found that the condensers would after a while become charged and inoperative; so he contrived a pipe 34 feet long (Fig. 1414), which led away from the condenser, its lower end being submerged in a tank, and inasmuch as such a column is greater than can be supported by the pressure of the atmosphere, the water would leave the condenser, which would then be occupied only by steam and air. The steam enters the chamber *A* by the bent pipe, and the water the chamber *E* by the other pipe, and passes in a shower through the perforations in the chamber, condensing the steam and carrying it down the discharge-pipe *F* into the cistern *G*. The pipe is so long that the weight of the column of water makes an almost perfect vacuum, and thus dispenses with an air-pump for discharging the heated water. The device is also used in vacuum-pans, etc. The pipe *F* is shown with a break and gap to indicate that a large portion is removed to bring the device within proportions convenient for display upon the page. See ASPIRATOR; AIR-PUMP (Fig. 115).

Fig. 1414.



Vertical Column Condenser.

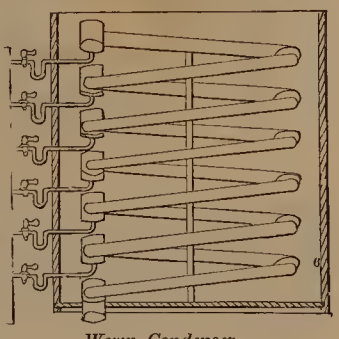
Fig. 1415.



Surface-Condenser.

The *surface*-condenser has a series of flat chambers or tubes, usually the latter, in which the steam is cooled by a body of water surrounding the tubes. The most secure way of fastening the tubes in the heads is Horatio Allen's wooden thimble, which swells after placing in position, and makes a tight joint. Distilled water for ships' use is obtained by the condensation of steam in a surface condenser. To render it more palatable it is artificially aërated and then filtered through animal charcoal.

Fig. 1416.

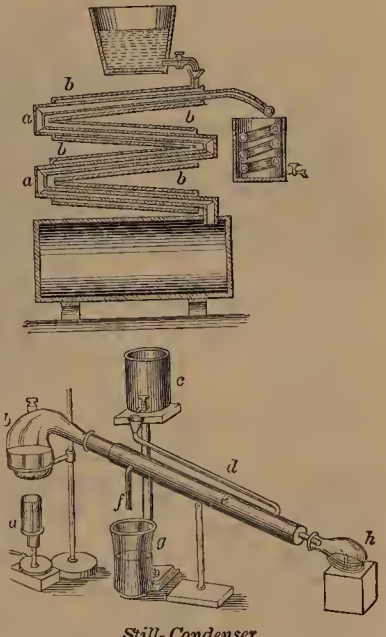


Worm-Condenser.

2. (*Distilling.*) The *still-condenser* is generally of the *worm-tub* form; the coil containing the alcoholic vapor traversing a tub which receives a constant accession of cold water, condensing the vapor in the coil. The liquid escapes at a cock below.

In the example, the liquor condensed in each coil may be separately withdrawn.

Fig. 1417.



Still-Condenser.

In Hadley's still the pipe rising from the still has successive condensers *b b* in ascending series, the liquid in the condenser jackets being gradually cooler as they recede from the still. The object is to eliminate by successive stages a liquid of given tenuity, and return the heavier condensed vapors.

In Liebig's, the neck of the still *b* passes through a water-jacket *e* to the receiver *h*. The jacket is furnished with a constant stream of water from cistern *c*, by pipe *d*, and exit *f*, to waste-cup *g*. *a* is the lamp.

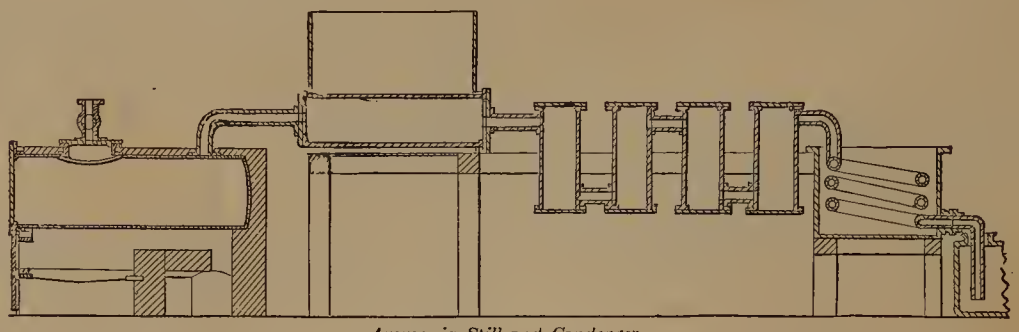
In Fig. 1418 is shown an apparatus for preparing purified ammonia, from the ammoniacal liquor of gas-works, by distillation, cooling, and treating the products with charcoal, and condensing the liquid.

Fig. 1419 is an apparatus in which a condenser *C* is placed between the vacuum-pan *A*, and the air-pump *G*, so as to condense any alcoholic spirit which may have formed in the sugar or molasses under treatment.

3. (*Metallurgy.*) An apartment in which metallic or deleterious gaseous fumes are condensed to prevent their escape into, and contamination of, the atmosphere.

These have been tried with more or less success in the copper-works of Swansea, the lead-works of England, and in various other manufactories. The

Fig. 1418.

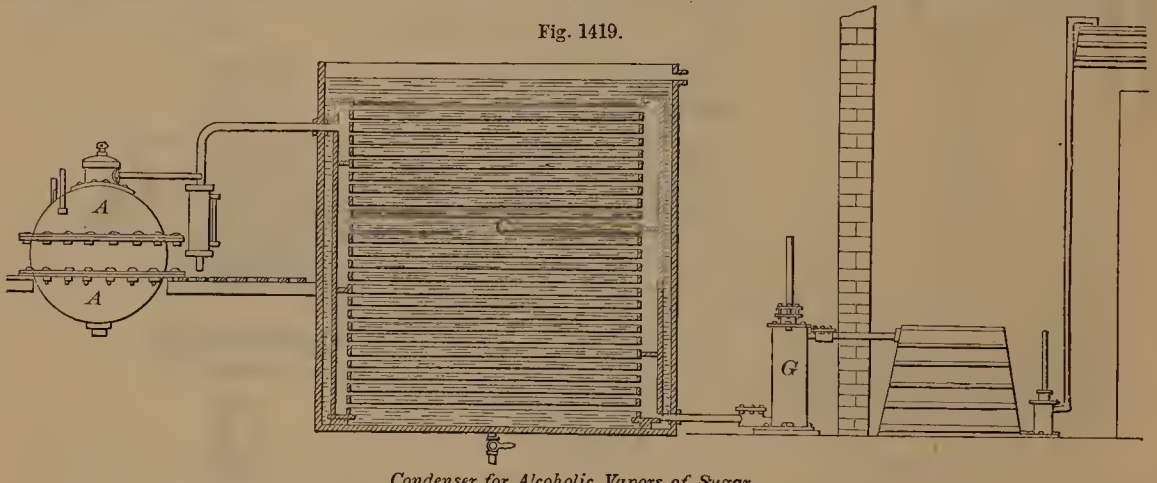


Ammonia Still and Condenser.

general feature is a prolonged duct for the fumes, with showers of water to condense the arsenical, sulphurous, and other fugitive volatile matters. The same devices serve an economical purpose in saving fugitive fumes of lead, zinc, mercury, sulphur, antimony, etc. See ARSENIC-FURNACE.

Fig. 1420 is a furnace and condenser for the dry distillation of ore of metals capable of assuming volatile condition with a moderate heat. The broken ore is fed from the hopper *C* into the revolving-drum *A*, which is heated by the furnace *B* and supplied with air under pressure by the pipe *E* from the air-pump. The heated ore is ground by the rolling balls *G*, and the fumes escape by the bent pipe *D* through the succession of sealed water-chambers *H H' H''* and pipes *D' D'' D'''* to the partitioned chamber *J* and the concluding vessel *K* which contains mercury. What remains volatile after this escapes at the

Fig. 1419.



Condenser for Alcoholic Vapors of Sugar.

chimney *L*. The post *M* supports one trunnion of the drum, and the other trunnion is a sleeve carrying the cog-wheel.

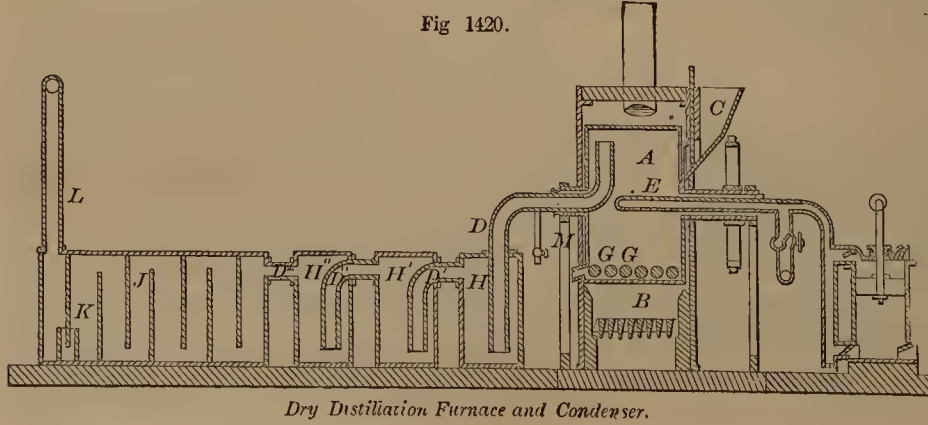
4. (*Gas-making.*) An apparatus in which the crude gas from the retort is cooled, and the ammoniacal liquor and tar extracted therefrom. See GAS-CONDENSER.

5. (*Sugar Manufacture.*) The Degrand (Derosne) condenser is in the train of sugar apparatus, and consists of a vertical series of convoluted steam-pipes *C*, over which trickles the sugar-cane juice from the defecator. See Fig. 1421.

6. (*Wool Manufacture.*) A device used in wool manufacture to compact the narrow slivers from a carding-machine so as to bring them into the condition of *slubs*. The narrow circumferential cards of the doffing-cylinder deliver narrow slivers which pass to the *condenser*.

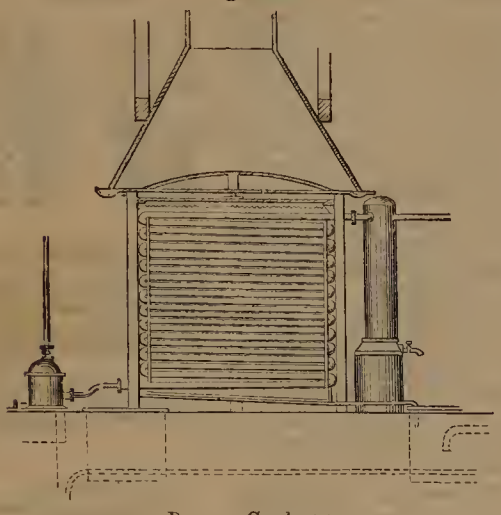
This consists of a pair of transverse rollers supporting a belt as wide as the doffing-cylinder is long, and receiving the slivers which are detached from the card-rings of the said cylinder by the doffing-knife. As the slivers pass from the doffer they run beneath an upper roller, which, in addition to its rotary motion, has an endways motion of two inches, back and forth in the direction of its length. By this means, each sliver is rolled upon the traversing belt in a manner similar to that of rolling it beneath the palm of the hand upon a table. It is thus

Fig 1420.



Dry Distillation Furnace and Condenser.

Fig. 1421.



Derosne Condenser.

rounded and compacted, the fibers becoming somewhat interlaced and closely associated, the nature of the wool tending materially to assist the operation. The endways motion of the roller is given by an eccentric at one end. The slubbings, as they are formed, are carried forward by the apron and wound upon a revolving bar; when filled, this is removed and placed in the mule, which draws from it as it would from bobbins placed on skewers on a creel.

7. A dentist's tool for packing foil for plugging teeth.

8. An air-pump for filling a chamber with air or gas at a pressure above the atmospheric. The condensing air-pump was known to Ctesibus, and figures largely in the "Spiritalia" of Hero.

9. (*Optics.*) A lens to gather and concentrate the rays collected by the mirror and direct them upon the object. There are several varieties, known as the *achromatic condenser*, etc. See CONDENSING-LENS.

10. (*Electricity.*) *a.* An instrument for concentrating electricity by the effect of induction. It usually consists of a confolded sheet of tin-foil, whose layers are separated by a thin sheet having a non-conducting surface.

Volta's electrical condenser is attached to a gold-leaf electrometer, and consists of two brass plates, one connected to the cap of the electrometer, the other supported on a brass pillar. The use of the instrument is to render apparent such portions of electricity as are too weak to be indicated by the electrometer only.

b. With induction apparatus, it is a device for absorption or suppression of the extra current, induced by the rapid breaks in the main current.

c. An instrument in which an electric spark passes between the poles in a closed glass cylinder, so as to be employed in burning metals in an atmosphere of any given tenuity or specific chemical character, to obtain the spectra of metals or gases free from accidental characteristics of the general atmosphere for the time being. A *spark-condenser*.

Con-dens'er-gage. A tube of glass, thirty-two inches long, open at both ends, the upper end being fixed to the condenser, the lower end dipping into mercury. It is to ascertain the degree of exhaustion in the steam-condenser.

Con-dens'ing-lens. A plano-convex (*bull's eye*) or double convex lens, to concentrate rays upon an opaque microscopic object.

Con-dens'ing-en'gine. (*Steam-engine.*) One in which the steam below or in advance of the piston is condensed, in order that a power equal to the cumulative force of steam and atmospheric pressure may act upon the effective side.

In contradistinction to the non-condensing engine, in which no provision is made for a partial vacuum in advance of the piston.

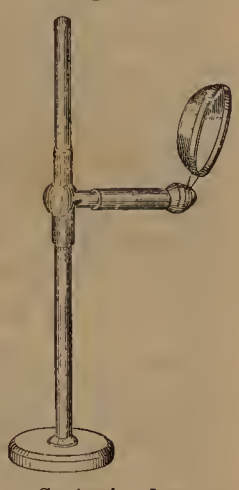
The object of condensation is twofold: —

To avail the atmospheric pressure.

To economize the fuel by making effective a part of the otherwise escaping heat.

Among the condensing-engines may be cited: — The *Cornish* and *marine engines* of various kinds. *Pumping* and *factory engines* of large size are usually *condensing*.

Fig. 1422.



Condensing-Lens.

The engines of the Eastern rivers and Northern lakes are usually *condensing*. Those of the Western and Southern rivers are usually *high-pressure* and non-condensing. The latter of a given power are lighter than the condensing, and the depth of water often determines the question, which kind of engine shall be adopted in a country or district.

Locomotives belong to the *non-condensing* class, securing compactness and power within moderate limits as to weight.

Con-dens'ing-syr'inge. A syringe whose valves are so arranged as to take air above and condense it below the piston, so as to condense air into any chamber to which the foot of the syringe is secured.

Con-duct'or. 1. (*Electricity.*) A term applied to a body capable of transmitting an electric current. Strictly speaking, all bodies are conductors of electricity, but those of relatively very small conductivity are known as non-conductors; for instance: —

The conductivity of copper being estimated at 40,000,000,

That of water is as 1.

Becquerel's table is as follows: —

Pure copper wire	100
Gold	93.6
Silver	73.6
Zinc	28.5
Platinum	16.4
Iron	15.5
Lead	8.3

In practice: A *prime* conductor collects and transmits the *frictional* electricity of the electrical machine. It was introduced by Bose in 1741.

A *lightning*-conductor, for conducting the *static* or *tension* electricity of the atmosphere harmlessly to the earth. It consists of a wire, rod, or slip of metal from the top of a house, tower, steeple, or mast, to the ground, or, better still, a ground-plate or system of buried iron pipes.

Gray and Wheler, in 1720–1736, made experiments to ascertain the distance through which electric force could be transmitted, using insulated metals.

Gray, in 1729, discovered the properties of electric conductors. "He found that the attraction and repulsion which appear in electric bodies are exhibited also by other bodies in contact with the electric." — WHEWELL.

Dr. Watson, in 1747, passed transmitted electricity

through 2,800 feet of wire and 8,000 feet of water, using the earth circuit.

Benjamin Franklin, in 1748, performed his experiments on the banks of the Schuylkill, "concluded by a picnic, when spirits were fired by an electric spark sent through the river, and a turkey was killed by the electric shock, and roasted by the electric jack, before a fire kindled by the electrified bottle." The latter was the Leyden jar, the invention of Muschenbroek and Kleist, three years previous.

Franklin flew his kite in Philadelphia in 1752, and proved the substantial identity of lightning and frictional electricity. He then invented the lightning-rod for the harmless passage of the electricity.

D'Alibard erected a lightning-rod in the same year.

Richmann of St. Petersburg, the following year, in repeating Franklin's experiment, was killed by a stroke of lightning.

Charles Marshall, in 1753, proposed insulated wires, suspended by poles, as electrical conductors for transmitting messages.

Lesarge, in 1774, used twenty-four electrized wires and a pith-ball electrometer as a mode of signaling. Lomond, in 1787, used one wire and a pith-ball.

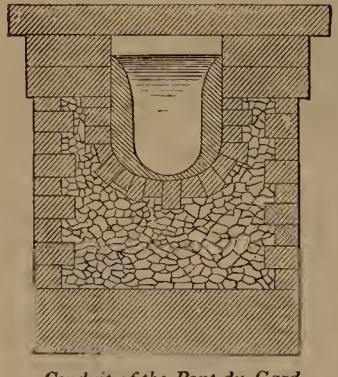
Reizen, in 1794, had twenty-six line wires and letters in tin-foil which were rendered visible by electricity.

Cavallo, in 1795, had one wire, and talked by sparks. He had an explosion of gas for an alarm.

2. (*Surgical.*) A grooved staff for directing a penetrating instrument in surgical operations; such as the forceps in extracting balls; lithontriptic instruments, etc.

Con'duit. (*Hydraulic Engineering.*) A pipe or passage, usually covered, for conducting water.

Fig. 1423.



Conduit of the Pont du Gard.

Cone. The vent-plug which is screwed into the barrel of a fire-arm (*A*, Fig. 1424). The outer end is the *nipple* for receiving the percussion-cap.

a, nipple.
b, square.
c, shoulder.
d, screw-thread.
e, vent.

Cone-bit. A boring-bit of conical form.

Cone-com'pass-es. A pair of compasses with a cone or bullet on one leg, to set in a hole. A *bullet-compasses.*

Cone-gear. A mode of transmitting motion, consisting of two cones rolling together.

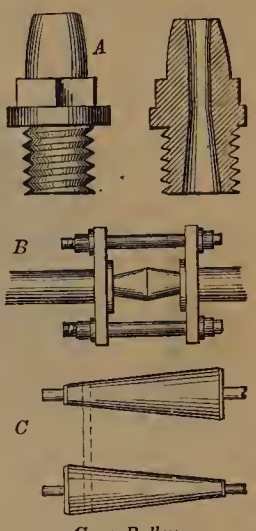
Cone-joint. A joint (*B*, Fig. 1424) formed by a double cone of iron inserted into the ends of the pipes to be joined, and tightened by screw-bolts, as shown in the figure.

This joint is quickly made and is very strong.

Cone-plate. The conical collar-plate of a *lathe-head.*

Cone-pul'ley. 1. An arrangement for varying the speed of the bobbin in spinning-machines, giving them a gradually decreasing velocity as the roving is wound thereon, so as to keep an equal strain on the roving (*C*, Fig. 1424). The lower pulley is driven with a uniform speed, and communicates motion to the other by a band which is slipped towards the larger end of the upper roller as the roving gradually fills the bobbin. See Fig. 751. The object is to obtain an equal pull on the roving, notwithstanding changes in the diameter of the *cop* as the winding proceeds.

Fig. 1424.



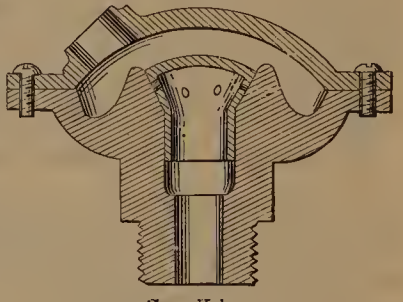
Cone-Pulley.

2. (*Machinery.*) A pulley with several faces of varying diameter, so as to obtain varying speeds of the mandrel. A *speed*-pulley.

Cone-valve. A hollow valve having a conical, perforated face, through which water is discharged when the valve rises, without impinging directly upon the valve-face or seat.

Cone-vise Coup'ling. A mode of connecting the ends of shafting, consisting of an outer sleeve *a* and two inner sleeves *b b*. The interior surface of portion *a* has two conical frustums, and the inner sleeves have gains for the bolts *c c*, which draw them together and jam them between the inclines of the outer sleeve and the surfaces of the respective rods.

Fig. 1425.

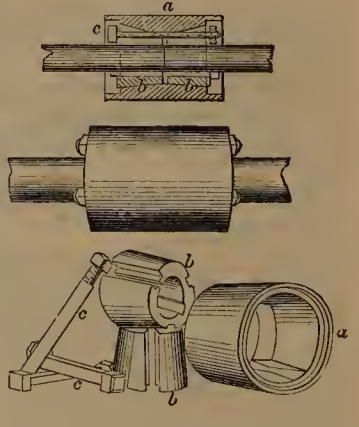


Cone-Valve.

Cone-wheel. The cone-wheel has several applications: —

1. Two frustums are in apposition, one having teeth on its face and the other a spirally arranged row of studs. The toothed wheel at its small end acts upon studs on the larger portion of the opposite wheel and conversely. The effect is to confer a regular variability of rotation to the stud-wheel from a regular rotation of the driving-frustum.

Fig. 1426.

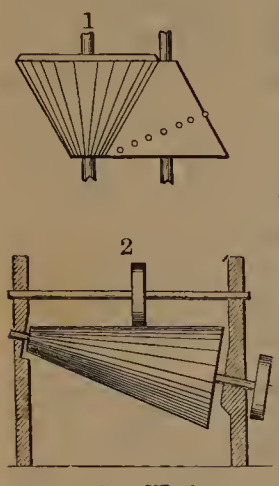


Cone-Vise Couplings.

2. The frustum, being driven by the motor, communicates motion to the wheel above it. This is not intermittent or variable, but is adjustable. The nearer the upper wheel is to the base of the cone, the faster will it rotate, and conversely.

Con-fec'tion-pan. A pan for making comfits or other confections which require to be rolled upon one another while being dried by heat. In the example, the shaft of the pan is secured to a ring by a universal joint. Its lower end rests in a socket made on the upper face of the wheel, which is rotated by

Fig. 1427.



Cone-Wheels.

gearing, and carries the shaft around with it, giving a wabbling motion to the pan. The shaft describes two cones connected at their common vertex, which is at the center of oscillation in the universal joint. A rolling motion is imparted to the pan, which is heated by steam or hot-air pipes beneath, communicating by flexible pipes with a furnace or boiler and an escape-pipe.

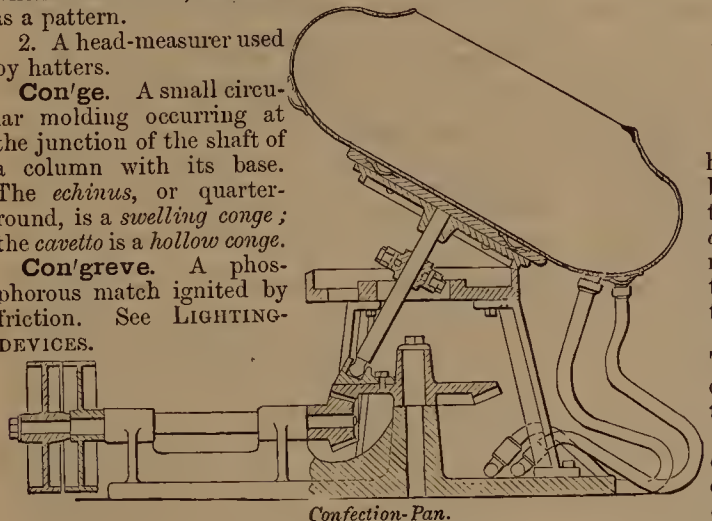
Con-form'a-tor. 1. A skeleton frame of slats and braces, adaptable to the person, and then, after adjustment, removable, so as to be laid upon cloth and allow the pattern to be marked thereon. Or an elastic jacket with points on the seams, upon which a paper may be impaled, and, when withdrawn, answer as a pattern.

2. A head-measurer used by hatters.

Con'ge. A small circular molding occurring at the junction of the shaft of a column with its base. The *echinus*, or quarter-round, is a *swelling conge;* the *cavetto* is a *hollow conge.*

Con'greve. A phosphorous match ignited by friction. See LIGHTING-DEVICES.

Fig. 1428.



Confection-Pan.

Con'greve-rock'et. The Asiatic rocket improved and employed as a formidable instrument of war by Sir William Congreve, 1804. See ROCKET; GUNPOWDER.

Con'i-cal-gear'ing. An arrangement of gearing in which a pair of cogged cones transmit through interposed pinions motion of the required speed.

Con'i-cal-pend'u-lum. A pendulum of a conical shape suspended by a wire and moving in a circular path in a horizontal plane. See PENDULUM.

A term sometimes applied to the rotating ball governor.

Con'i-cal-pul'ley. *Conical-pulleys* are used in cotton machinery where a gradually increasing or decreasing speed is required. See CONE-PULLEY.

Con'i-cal-valve. 1. A form of valve for water and steam engines. *a* is the valve-seat, made tapering so as to fit into the valve-chamber of a pump. Upon the rim of this is fixed the bridge *b*, serving both as a guide and a stop for the valve *c*, whose lower stem enters the sleeve *d*.

2 shows a conical frustum *c* having a stem in the bridge-piece *c* and a seat *a*.

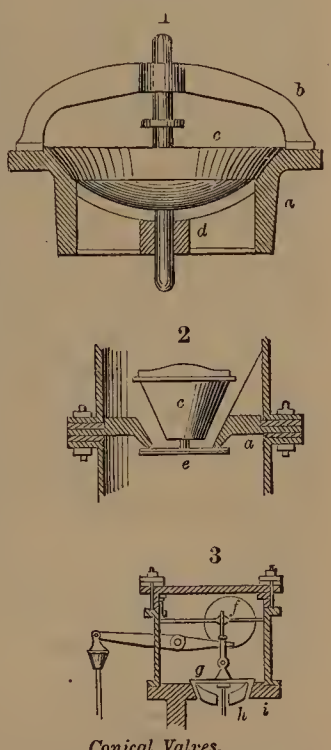
3 shows Watt's conical valve *g h*, with a stem in the bridge *f*, and operated by a lever and cord.

Con'i-cal-wheel. A wheel shaped like a frustum of a cone, and used in many ways: as a roller for turning curves in moving heavy bodies; the cone-pulleys are forms of wheels for changing speed; used in spinning-machines and lathe-heads; the fusee is a conical-wheel with a spiral track for the chain.

Co-nis'si-net. The stone which crowns a pier, or that lies immediately over the capital of the impost, and under the sweep.

Con-nect'ing-link. A link which has a movable section by which it may be made an intermediate connection between two links of a broken chain. The *open*-ring or *lap*-ring is a form of connecting-link used in attaching a single-tree to a double-tree, and the latter to the plow-clevis.

Fig. 1429.



Conical Valves.

Con-nect'ing-rod. (*Machinery.*) *a.* The rod connecting the piston-rod or cross-head of a locomotive engine with the crank of the driving-wheel axle.

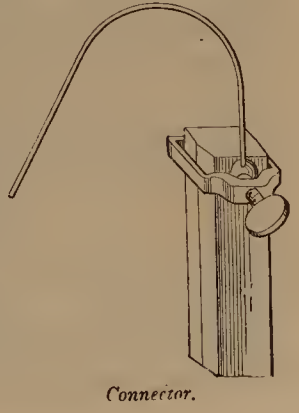
b. The coupling-rod which connects driving-wheels on the same side of a locomotive. By coupling other pairs of driving-wheels to the pair which is immediately actuated by the engines, slip is avoided, as a greater number have a tractive adherence to the rails and are not mere bearers.

c. The rod connecting the cross-head of a beam-engine with that end of the working beam which plays over the cylinder.

The rod depending from the other end of the beam is the pitman or pump-rod, as the case may be.

Con-nect'or. 1. (*Electricity.*) A device for holding two parts of a conductor, as the two wires for instance, in intimate contact. A *binding-screw;* a *clamp.*

Fig. 1430.



Connector.

2. The English term for a car-coupling.

Con'science. A plate resting against the drill-head and enabling the pressure of the breast or hand to be brought upon the drill. A *palette.*

Con'sole. (*Building.*) A bracket whose *sole* or shelf is supported by a pair of flowing scrolls.

Con'stant Bat'ter-y. A name applied to the Voltaic battery of Professor Daniell, in which the zinc is separated from the copper by a porous diaphragm, such as bladder or unglazed porcelain, two distinct liquids being used. The part of the battery containing the zinc is charged with dilute sulphuric acid, and the part containing the copper is charged with sulphate of copper. See GALVANIC BATTERY.

Con-struc'tion-way. (*Railroading.*) As distinguished from the finished or *permanent* way of a railroad. It is a temporary way used in transporting the gravel, etc., of the *cuttings* to the *fills* or places where the embankments are to be made. Also in obtaining gravel from other points where the cuttings for the track do not furnish it.

Also used in transporting material and men to the point at which the work is progressing and in carrying ballast for the track.

Con'tact-lev'el. A valuable adaptation of the spirit-level used by certain instrument-makers for the production of exact divisions of scales, and generally for the determination of very minute differences of length.

This device was invented about the year 1820, by Repsold, a celebrated instrument-maker of Hamburg, whose mechanical genius first manifested itself in the repairing of chronometers while he was mate of a vessel at sea.

It consists of a very delicate level pivoted at its middle and across its length, with a small tilt-weight at one end, which tips always in one direction. From the center of the level downward, a short rigid arm extends with a plain polished surface perpendicular to the chord of the level, and against which the contact is made. The carrier of this arrangement is either fixed, or mounted on a slide, governed by a micrometer screw. If now the end of a rod terminating in a hardened steel point be advanced horizontally till it bears against the contact-arm, the level will gradually assume the horizontal position, and the movement of the bubble as indicated by the scale upon the glass will depend upon the relation between the radius to which the level-tube is ground, and the length of the contact-lever. If the latter is $\frac{1}{2}$ an inch long, and the radius of the glass tube is 400 feet (levels for astronomical purposes are ground to a sweep of 800 and 1,000 feet radius), we have the relation between the lever and radius as 1 is to 9,600, and as $\frac{1}{50}$ of an inch can readily be read from the level-scale, $\frac{1}{480000}$ of an inch (9,600 × 50) will be the difference in length which each division on such a scale indicates.

When it is remembered that such a determination of length can be repeated indefinitely, and that the readings are made without the aid of a magnifying-glass or artificial illumination, the perfection and beauty of the method will be appreciated.

Con-tin'u-ous Rail. A rail made in sections with a longitudinal vertical joint, and the sections laid together, breaking joint.

The continuous rail has been tested on the New York Central Railroad and on other American lines. Its smoothness of action left but little to be desired while it was new, but it soon deteriorated. The rail is made in sections which have a longitudinal vertical joint; the parts being united by bolts and nuts, with the addition of *fish-plates* at the transverse joints. The sections *break joint*, that is, the junction of two pieces on one side comes opposite to an unbroken surface of the rail on the other side. See FISHING.

Cont'line. The space between the strands on the outside of a rope. In *worming*, this space is filled up with spun yarn or small rope, which brings the rope so treated to a nearly cylindrical shape, either to strengthen it or to render the surface smooth and fair for *serving* or *parceling*.

Con-tour'. (*Fortification.*) *Natural contour:* the form of the ground surface with respect to its undulations.

Line of contour: a horizontal plane intersecting a portion of ground.

Con'tra-bas'so. (*Music.*) The largest and deepest-toned of the series of stringed instruments played with the bow. A *double-bass.*

Con-trac'tion-rule. A rule in excess of standard measurement used by pattern-makers, to allow for the contraction of the cast metal in cooling.

Con'tra-mure. An out-wall built about the wall of a city or fortification.

Con'trate-wheel. A *crown*-wheel or *face*-wheel, in a watch. Also known as the *fourth* wheel. Its cogs project perpendicularly to the plane of the wheel. It gave a name to the old *vertical* or *verge* movement, in clocks and watches, where a crown-wheel is placed in engagement with the pinion on the arbor of the escape-wheel, in order to bring into horizontal position in the clock the arbors of all except the escape-wheel. The *anchor* pallet has put the contrate-wheel out of use in clock escapements, and the lever and other movements have superseded the old *vertical* movement in watches.

Con'tra-val-la'tion. (*Fortification.*) An advanced offensive work consisting of a trench and parapet to check sallies of the garrison.

Con'tra-va'peur. A French invention, a partial substitute for brakes. It consists in injecting a small stream of water from the boiler into the exhaust-pipes or passages before and during the reversal, so as to bring a counter-pressure of steam upon the piston.

Con-trol'ler. (*Nautical.*) A cast-iron block having depressions on its upper surface adapted to fit the links of the cable which passes over the block on its way from the locker to the hawse-hole.

Controllers are bolted to the deck at various points in the line traversed by the cable. The latter tends to drop into the hollow of the block which then arrests the motion. The cable may be lifted out of the hollow, by the short arm of a lever which rises from the bottom of the hollow in the block.

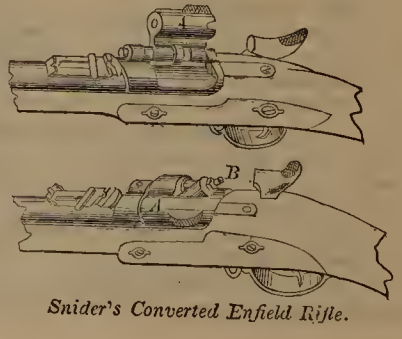
Con-ver'sion. (*Shipbuilding.*) The cutting — usually with the saw — of logs of timber into pieces nearly of the shape required.

Con ver-sa'tion-tube. An elastic tube with a mouth-piece about two inches in diameter, and at the other end an ear-piece. The neck is a yard or more in length, made of spiral wire covered with caoutchouc and overspun with mohair or silk.

Con-vert'ing. 1. (*Fire-arms.*) A name applied to changing muzzle-loading arms to breech-loaders, and which, in some form, has taken place with the small-arms of most national armaments.

From among the various competing plans for converting the Enfield rifle of the English service into a breech-loader, that of Snider was adopted. The cost of conversion is about 15*s.* English for each rifle.

Fig 1431.



Snider's Converted Enfield Rifle.

The method is as follows:—

About two

inches of the barrel are cut away at the breech, and a solid breech-stopper *A*, working sideways on a hinge, is placed in the opening thus made. Through this stopper passes a piston, one end of which, *B*, when the breech is closed, receives the blow from the hammer, while the other communicates it to the center of the cartridge, thus firing the latter. The empty cartridge-case is retracted after each discharge by means of sliding back the stopper on its pintle, when the tilting of the piece tips out the shell and another can be inserted. It weighs 9 pounds 5¼ ounces, and has been fired fifteen times in a minute.

The Springfield (U. S.) rifle is also *converted* into a breech-loader. See FIRE-ARM.

2. *Rasing*, or reducing a ship by a deck; or otherwise changing or degrading it into a battery-vessel, or a receiving or prison hulk.

3. Decarbonizing, or changing cast-iron into steel. See CONVERTOR; BESSEMER PROCESS.

Con-vert'ing-fur'nace. One for converting wrought-iron into steel. Wrought-iron is iron in its greatest purity, though it is seldom that all the impurities are perfectly eliminated.[1] Steel contains a portion of carbon, more or less, and is a carburet of iron. Cast-iron contains a much larger amount of carbon. Qualities of each depend upon the quantity and nature of other matters which are combined with the iron, some being undesirable but difficult of removal, and others being purposely added to confer a quality or to neutralize extraneous matters which are present.

The bars of iron are cut by shears to the required length and are placed in layers in a flat, narrow furnace, with intervening layers of pounded charcoal. Above the alternate strata of iron and charcoal is a covering of ferruginous earth. The mass being heated, the carbon is in some way absorbed by the iron, which is converted into steel. This is known as CEMENTATION (which see).

The resulting *blister* steel, so called from the blisters formed by bubbles of gas which was eliminated during the process of conversion, is then cut up, reheated and hammered, and becomes *shear* steel.

Blister steel, cut up, heated in crucibles, poured into molds, and the ingots hammered into shape, becomes *cast*-steel.

Con-vert'or. An iron retort in which molten iron is exposed to a blast of air, the oxygen of which burns out the carbon and some other impurities of the iron; a subsequent addition to the charge makes a further chemical change, and the result is a grade of steel. It is used in the Bessemer process.

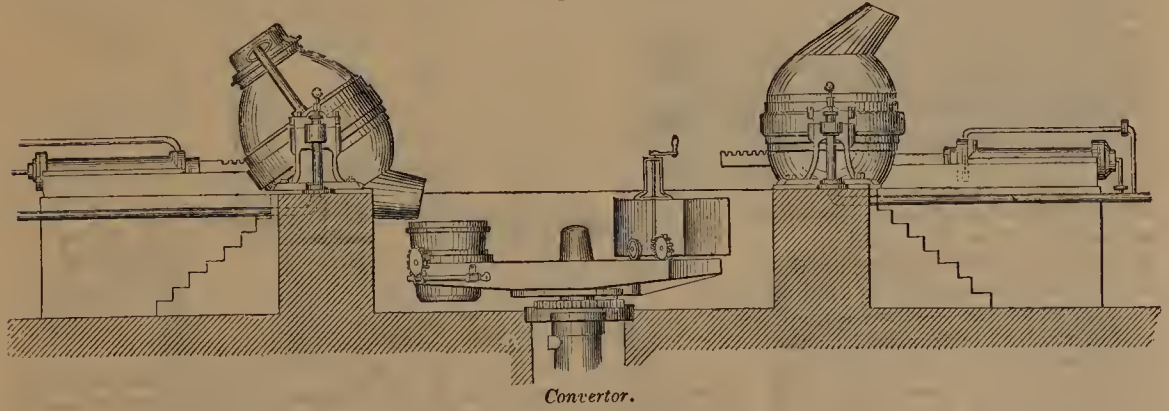
Condensing, from a brilliant description by Mr. R. W. Raymond of the process as conducted by Mr. Holley, it may be briefly described as follows: —

The five-ton convertor is an iron vessel 14½ feet high and 9 feet in diameter externally, of a bulbous shape, and hung upon trunnions. The lower hemisphere is truncated, giving a flat bottom, five or six feet in diameter. The upper hemisphere terminates in a large neck inclined sidewise, so that a flame issuing under pressure from the mouth of the upright convertor is obliquely directed into a chimney, guarded by a hood. The whole vessel has a rude resemblance to a pear. It is supported by heavy trunnions on each side of the center, and revolved upon these by hydraulic power.

This huge iron bottle, with its neck awry, is lined with a foot of refractory silicious material, known as *ganister*, to preserve the iron shell. The trunnion is hollow, and a passage from it runs down the outside, looking like a strong rib in the iron surface, to the bottom, where it communicates with the tuyeres. The bottom of the Holley convertor is movable, and when taken out looks like a great plug of fire-brick, two feet high, resting upon a cast-iron disk. The tuyeres, or nozzles for the blast, are imbedded vertically in the lining, and present ten groups, each containing a dozen three-eighths inch holes. The aggregate area of these openings is equal to that of a single tuyere 4.1 inches in diameter, but the thorough agitation produced by dividing the blast secures much greater useful effect. The pressure of the blast is twenty-five pounds per square inch.

The convertor in its upright position, being heated by a charge of coals and the blast, is turned mouth downward to vomit out the glowing coals, then upon its side to receive its charge, which runs from the cupola furnace above, along a trough, and plunges into the mouth of the convertor. The position of the retort at this time prevents the charge from running into the tuyeres before the blast begins. Afterwards the pressure of the air itself keeps the passages clear. Then the blast is let on, and the convertor swung back to a vertical position. A tongue of white flame comes roaring out of the

Fig. 1432.



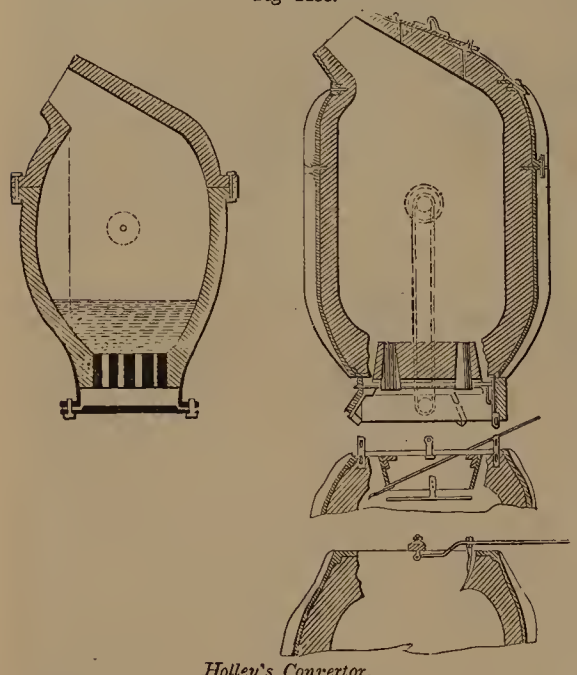
Convertor.

mouth. The silicon of the pig oxidizes first, without very intense flame; but as the graphite and especially the combined carbon begin to burn also, the heat rises to some 5,000° F., and the light is so brilliant as to cast shadows across full sunshine.

In fifteen or twenty minutes the marvellous illumination ceases more suddenly than it began. The volume and brilliancy of the flames diminish together with startling rapidity. This change of the Bessemer flame marks the elimination of most of the carbon, and indicates the critical moment. When it arrives, the blast is stopped, the convertor is

turned upon its side, and 600 pounds of melted spiegeleisen are turned into it, as the pig was previously charged. The reaction is instant and violent. The manganese of the spiegeleisen combines with any sulphur that may remain in the bath, forming compounds which pass into the slag. It also decomposes in the slag silicates of iron, taking

Fig. 1433.



Holley's Convertor.

the place of the iron and returning it to the bath. Finally, the carbon and manganese together reduce the oxide of iron formed during blowing, which would destroy the malleability of the iron. This is quickly accomplished, and now the gigantic convertor, like a monster weary of drinking boiling iron and snorting fire, turns its mouth downward, and discharges its contents into a vast kettle or ladle, brought underneath for the purpose by one of those intelligent cranes that stand around so silent and so helpful. The ladle is swung over the molds ranged round the side of the semicircular pit below, like a row of Ali Baba's oil-jars, each capable of containing a bandit. The white, one would almost say transparent, metal is drawn off into these through a tap-hole in the bottom of the ladle, retaining the slag which floats on the surface till the last. When the first mold is filled, the plug is closed, the ladle swung round to the second mold, and so on till all the steel is thus cast into ingots, the size of which varies with the kind of work for which the steel is required. A thin steel plate is placed on the top of each casting immediately the mold is filled, and over this a bed of sand is placed, and speedily and firmly pressed down.

As soon as the ingots have solidified, and while they are still glowing, the molds are lifted off them by means of an hydraulic crane, and afterwards the ingots are picked up by tongs attached to the same machinery, and are carted away, all red-hot, to the hammer-shops, where they are thumped and rolled or otherwise tortured into their required forms of rails, tires, and plates.

Con'vex Lens. One having a protuberant form.

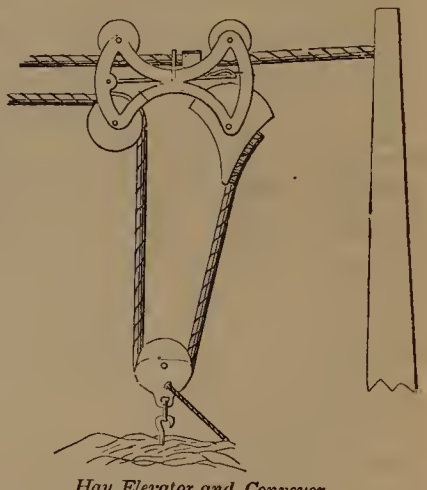
A *plano-convex* lens has one flat and one bulging side.

A *concavo-convex* or *convexo-concave* has one protuberant and one depressed side.

A *convexo-convex* or *double-convex* has two convex surfaces, not necessarily of the same radii. See LENS.

Con-vey'or. A mechanical means of carrying objects. A term applied usually to those adaptations of band-buckets or spirals which convey grain, chaff, flour, bran, etc., in thrashers, elevators, or grinding-mills; or materials to upper stories of warehouses or shops, or buildings in course of erection. (See ELEVATOR.) Also applied to those arrangements of carriages traveling on ropes, by which hay lifted by the horse-fork is *conveyed* to distant parts of a barn or mow (Fig. 1434); or materials to a structure, as shown in the full-page cut opposite to page 49.

Fig. 1434.

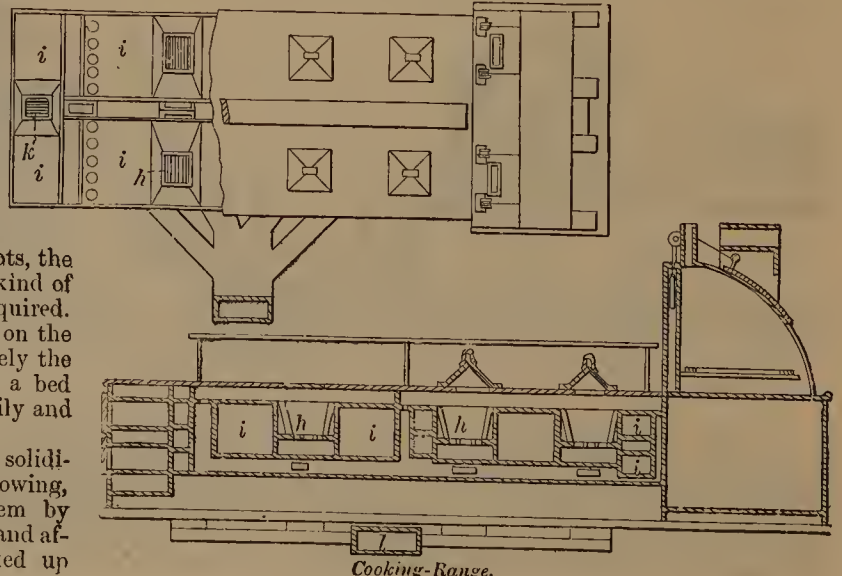


Hay Elevator and Conveyor.

Con'voy. One name of a friction brake for carriages.

Cook'ing-range. A cooking arrangement in which the devices — grate, oven, boiler, etc. — are placed in a row (ranged), and set in brickwork within the fireplace, so called. Portable ranges are not so built in, but are cooking-stoves. One of the

Fig 1435.

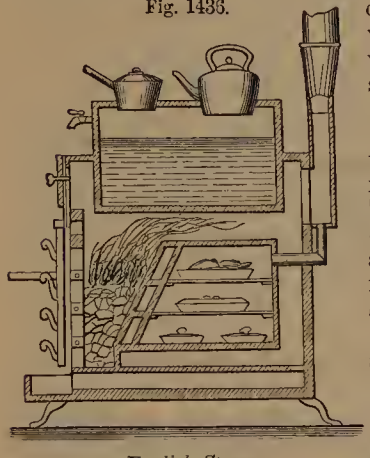


Cooking-Range.

latter kind, for hotel or steamboat use, is shown in Fig. 1435, in which the fire-chambers *h h k*, ovens *i i*, and flues, are so arranged that the range has two fronts and an end, so that attendants can have ready access to all parts of the range. The products of combustion are utilized in heating closets below the ovens for warming plates and keeping the viands warm, and thence dive into the sub-floor flue *l*, which connects with the chimney of the building.

Cook'ing-stove. A structure, usually of iron, containing a fuel-chamber and ovens, with holes into which pots may be set to boil the contents.

Fig. 1436.

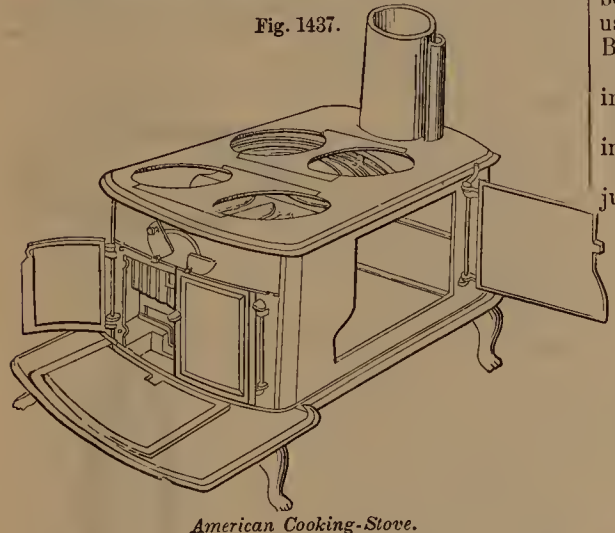


English Stove.

Stoves are comparatively uncommon in England. They prefer the open fireplace for apartments and the range for kitchens. See RANGE.

The English cook-stove of forty years since is shown in the annexed cut. The front of the stove is a grate at which joints may be roasted. Between the fire-back and the oven is an air-flue. A part of the front may be lowered, as shown in dotted lines, to form a shelf for stewing.

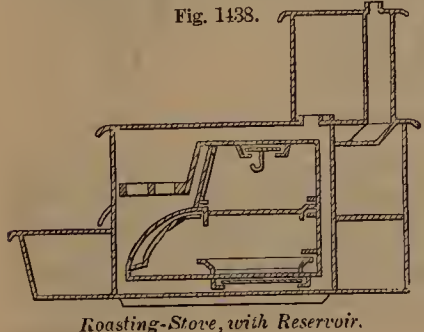
Fig. 1437.



American Cooking-Stove.

A plate may be in front to form a blower. The fire is directed above or below the oven by means of dampers. The passage between the fire and the oven is supplied by air from below, and discharges into the oven, from whence a pipe discharges the fumes of the cooking into the chimney. This is said to have the effect of roasting rather than baking.

Fig. 1438.

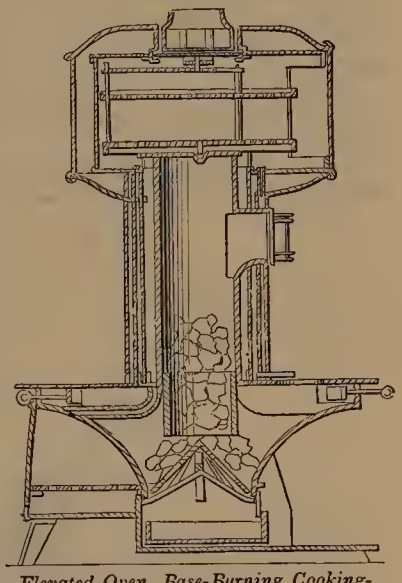


Roasting-Stove, with Reservoir.

Fig. 1437 represents an ordinary form of stove, the doors being opened and lids off to expose the interior.

Fig. 1438 is an attempt to secure a roasting-stove by means of direct radiation from the fire-box into the oven through the back fire-plate and the front oven-plate for roasting or broiling; but this direct radiation is shut off when the oven is used for baking.

Fig. 1439.



Elevated-Oven, Base-Burning Cooking-Stove.

Fig. 1439 has an elevated oven and a coal-magazine, being an application of the base-burning principle to the cooking-stove. The base is connected by vertical flues to the upper part containing the oven. There are many hundreds of varieties; some differences being actual, some imaginary.

Cool'er. 1. (*Brewing.*) A large vat, relatively broad and shallow, in which the beer is cooled. Mechanical appliances are sometimes used to expedite the process. See LIQUID-COOLER; BEER-COOLER.

2. (*Domestic.*) *a.* An ice-chest or safe for viands in hot weather. See REFRIGERATOR.

b. A tin vessel with lid, faucet, and non-conducting jacket, for containing ice-water.

3. (*Sugar.*) A trough in which condensed cane-juice from kettles or vacuum pans is placed to

Fig 1440.

Sugar-Cooler.

crystallize. In Cuban sugar-houses each cooler holds 1½ hogsheads.

Cool'ing-floor. A large shallow tank in which *wort* is cooled. Horizontal vanes for causing a circulation of air over the wort are called *flighters*. Apparatus for bringing the wort in contact with artificially cooled surfaces are REFRIGERATORS (which see).

Coom. A term applied to refuse matters, such as soot, smoke-black, coal-dust, the mold which forms on some liquids, the drip of journal-boxes, etc.

Coop'er-ing. The art of making casks and barrels.

The invention is ascribed by Pliny to the people who lived at the foot of the Alps. It seems to have attained great excellence at an early day.

The business is divided into several kinds, which may or may not be carried on together.

Dry coopering consists of making barrels for flour, hams, eggs, grain, sugar, etc.

Wet or *tight* coopering is for whiskey, molasses, pickled meat, cider, vinegar, etc.

White coopering consists of buckets, tubs, churns, etc.

Bucket-making and *barrel-making* are generally carried on in factories, special machinery being employed.

The accompanying cut gives an impression that the business of coopering is conducted on energetic

Fig. 1441.

Japanese Coopers (from a Native Picture).

principles. While the Hindoo bricklayer sits at his work, and the blacksmith of some other country — name forgotten — holds his tongs with his foot, it appears that in Japan one holds the driver and another climbs upon the trussed cask to use the hammer.

Coop'er's Ham'mer. A hammer with a narrow *peen*, whose length is in the plane of the motion of the hammer; used for battering and flaring an iron hoop to fit the bulge of a cask. Also called a *flue-hammer*.

Coop'er's Plane. A long plane set in slanting position, sole upward, upon which staves are jointed. A *jointer*. Planes and shaves are or may be used in smoothing the work. See list under next article.

Coop'er's Tools:—

Adze.
Auger. Taper
Barrel-machine.
Barrel-head machine.
Borer.
Bucket-machine.
Bung.
Bung-cutter.
Butt-howel.
Chiueing-machine.
Cleaving-knife.
Cooper's hammer.
Cradle.
Cresset.
Croze.
Crozing-machine.
Doweling-machine.
Drawing-knife.
Driver.
Flagging-iron.
Flue-hammer.
Frow.
Gathering-hoop.
Heading-circler.
Heading-knife.
Heading-machine.
Hollowing and backing-machine.
Hoop.
Hoop-bending machine.
Hoop-cutter.
Hoop-dressing machine.
Hoop-driver.
Hoop-punching machine.
Hoop-riving machine.
Hoop-shaving machine.
Hoop splaying and bending machine.
Howel.
Inshave.
Jigger.
Jointer.
Overshave.
Pack.
Pail-machine.
Raising-knife.
Rounding-machine.
Setting-up machine.
Shook.
Spoke-shave.
Stave.
Stave-bender.
Stave-cutter.
Stave-dresser.
Stave-jointer.
Stave-machine.
Stave-sawing machine.
Stave-setter.
Tap-borer.
Truss-hoop.
Turrel.
V-croze.
Vyce.

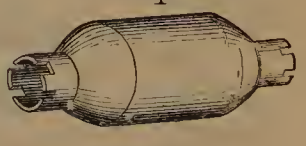
Coo-thay'. (*Fabric.*) A striped satin made in India.

Cop; Cop'pin. 1. (*Spinning.*) A conical ball of thread wound upon a spindle or tube in a spinning-machine, and removable by slipping therefrom.

The *copping-reel* is the means of distributing the roving or yarn up and down on the bobbin, so as to wind it into the form required. The form (1, Fig. 1442) is the result of a scheme for giving each layer an equal length of yarn, so that the length of the layer on the bobbin shall *decrease* as its diameter *increases*.

Fig. 1442.

1



The increase in diameter renders necessary a decrease in speed, in order that it may wind equal yarn in equal times. This is accomplished by a device called a *cone-pulley* (which see).

2

Bobbin and Cop.

The *cop* (2, Fig. 1442) made on the spindles of the mule is of a different form, the yarn being wound in a double cone as a foundation *a b c d*, upon which the rest is built upward in successive layers, which are easily unwound, either by the reel or in the shuttle. The conical *spindle-form* with conical ends is preserved (*a b c e f*), as being the most compact and self-sustaining, consideration being had to the form of the shuttle in which it is to lie.

2. A tube, also known as a *quill*, for winding silk upon in given lengths for market; a substitute for skeins. Being hollow, it may be placed on the spindle or skewer of any winding-machine. The silk end is secured in a slit, as in the case of spools.

Cope. 1. (*Founding.*) The upper part of a mold; the lower is the *drag*. It may consist of

several parts, which divide by a vertical joint and mutually rest upon the *drag*. See FLASK.

It is also known as the *cap*, *coat*, *top*, *case*, *dome*. Some of these are mere synonymes, others refer to specific forms of the object.

2. (*Architecture.*) A crown, arch, or arched lintel. The root-meaning is the same as *cap* or *cover*.

Cope-chis'el. A chisel adapted for cutting grooves.

Cop'ing. (*Masonry.*) The top, protecting course on the top of a wall. It is of three kinds:—

Parallel coping, level on top.

Feather-edged coping, bedded level and sloping on top.

Saddle-back coping has a curved or doubly inclined top.

The under edge should be *throated*, that is, grooved, so that the drip will not run back on the wall, but drop from the edge.

Cop'per. 1. A red metal. Equivalent, 31.7; symbol, *Cu.* (cuprum); specific gravity, 8.7 to 8.9, according to density; fusing-point, 1996° F. A moderately hard, malleable, ductile metal. A good conductor of heat and electricity.

Its uses are very numerous. In the shape of wire and sheets its employments ramify through all the uses and conveniences of commerce and the household.

The alloys, brass and bronze, are the most useful of that interesting class of compounds. Besides these, it enters into the composition of albata, bell-metal, speculum-metal, etc. See ALLOY.

Its salts are usually poisonous, but brilliant, and are extensively used in the arts.

It forms the material for the lower denomination of the coins of most civilized nations.

Copper was known and used long before iron. The discovery, so far as the nations depending on the Western Asiatic civilization is concerned, is probably due to the Scythians. Aristotle, Pliny, and others give the names of the supposed discoverers, and carry it back to the era of fabulous divinities. The first alloy of copper was that with tin, making a bronze; afterward with zinc, making a brass. The same name is applied to both in the Greek, also in the Latin. The tin for the alloy was found in the islands called Cassiteris or Cassiterides, which are the Scilly Islands and the promontory of Cornwall. "Midacritus," says Pliny, "was the first who brought tin from thence, and the islands received the Greek name of the metal." Herodotus makes the same statement as to the source of the metal, and the same district is yet rich in tin, and is worked to great profit. The tin brought by the Phœnicians to Solomon to alloy the copper for the vessels of the Temple at Jerusalem made other trips when it was carried to Babylon, returned under Cyrus, was retaken by Antiochus Epiphanes, and was thence scattered, probably in the form of coin.

The references in the Bible to copper are very infrequent, considering it to be the commonest metal they had. It is but twice mentioned, while *brass* (so translated) is mentioned thirty-one times. It should be rendered *bronze*, its alloy being tin, and not zinc.

Copper was in common use in ancient Assyria. No iron was found in the excavations of Khorsabad by M. Botta, who was the first successful explorer of the *tumuli* on the Tigris. Iron armor, inlaid with copper, was found by Layard at Nimroud.

Sheet-copper was made in ancient Egypt,

Hesiod speaks of the third generation of men "who had arms of copper, houses of copper, who plowed with copper, and the black iron did not exist." In the Homeric poems, knives, spear-points, and armor were still made of copper.

The process of reducing copper ore depends upon its character. Swansea, in South Wales, has the principal part of the work, ores being brought there from Cornwall, Devonshire, Spain, South America, Australia, Africa, and the United States, and there they are smelted and refined. See COPPER-FURNACE.

The Mansfield (Prussian Saxony) process consists in roasting the calcareous ore to expel the sulphur and oxidize the metal; the ore is then smelted in a cupola, the slag and molten metal being drawn at two tap-holes into separate cisterns. The *matte*, combined sulphurets of iron and copper, is repeatedly roasted, and the resulting sulphate of copper removed by lixiviation. When silver is present, it is removed with lead, and that separated by cupellation.

With the Longmaid process the copper pyrites is roasted in the presence of chloride of sodium. A double decomposition ensues; sulphuric acid is formed and attacks the soda, the copper becomes a soluble sulphate, the iron is in the form of peroxide; the escaping fumes of chlorine impregnate lime, which becomes bleaching-powder.

Fig. 1443.

Brewer's Copper.

The wet treatment of copper is by grinding and roasting; sulphuric acid is formed and attacks the oxide of copper, the resulting sulphate is dissolved away, and the metal precipitated by peroxide of iron.

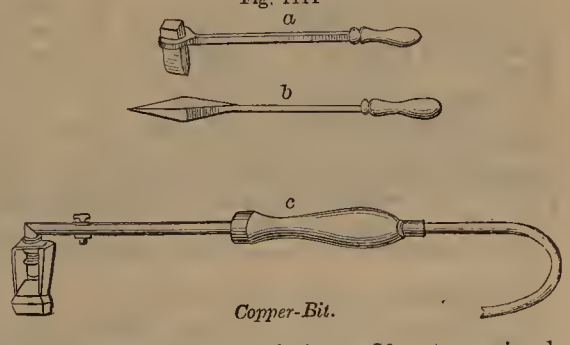
In making sheet-copper the plates of copper from the smelting and refining works are heated, in small ovens called *muffles*, to a bright-red heat, and then repeatedly rolled; the rollers, at each operation, being brought nearer together. The plates thus produced are called *blanks*, which are again heated in the *muffle* and rolled again. A repetition of the process makes *sheet-copper*.

2. A large vessel — usually of copper — set in brickwork, and used by launders, coopers, brewers, bleachers, dyers, and on shipboard; in boiling clothes, staves, cloths, etc., or in making extracts or decoctions.

Cop'per Al-loys'. Copper is the most useful of all metals for alloys, and a list of its combinations is given on page 61 *et seq.*

Cop'per-bit. A pointed piece of copper, riveted to an iron shank and provided with a wooden han-

Fig. 1444



Copper-Bit.

dle. It is used for soldering. If not previously tinned, it is heated to a dull red in a charcoal fire; hastily filed to a clean metallic surface; then rubbed immediately upon a lump of sal-ammoniac, and next upon a copper or tin plate, upon which a few drops of solder have been placed. This will completely

coat the tool, which may be wiped clean with a piece of tow, and is ready for use. *a b* show different positions of the bit on its stock.

e is a device by which a gas-jet is applied to the back of the *copper-bit*, admitting of its constant use, without continued reference back to the furnace for reheating. The gas passes through the elastic tube, and thence through the handle and shank, whence it issues in a jet upon the back of the bit, in quantities determined by the stopcock. The elastic tube allows the tool to be moved readily in any direction.

Cop'per-bot'tomed. (*Shipbuilding.*) Having that portion of the outer skin which is exposed to the water sheathed with copper, as a protection against that great bore, the *Teredo navalis*.

Cop'per-cap. The copper capsule, charged with a fulminate and placed on the nipple of a fire-arm, to explode the charge when the hammer falls.

Cop'per-faced. (*Type.*) Having a face of copper upon a shank of type-metal.

Cop'per-fast'ened. (*Shipbuilding.*) Having the planks, etc., fastened with copper bolts, in contradistinction to iron; the latter being liable to rust, especially in contact with oak and by exposure to wet.

Cop'per-fur'nace. Copper-smelting, as practiced at Swansea, Wales, consists of the following processes: —

1. *Calcination of the ore.* This is conducted in a reverberatory furnace. (See CALCINING-FURNACE; COPPER.) The charge is introduced by hopper on to the hearth of the furnace, where it is exposed for 11½ hours to a flame, which disengages the sulphur and arsenic in a gaseous shape.

2. *Separation of the copper from gangue and oxide of iron.* This is accomplished in a melting-furnace, which collects the copper in a *matt*, consisting of sulphuret of copper and iron, the gangue and oxide of iron in the shape of scoriæ, and drives off certain amounts of sulphur and other volatile matters.

Each charge is in the furnace four hours. The *matt* collects in the basin of the hearth, and is run off into a cistern, whereby it is granulated. The scoriæ is run off into sand-pits of small size, where it forms bricks, which are examined for traces of copper and the richer portions retained for remelting.

The copper is in the condition called *coarse metal.*

3. *Calcination of the coarse metal.* This is performed in a reverberatory furnace, the heat being gradually increased for 36 hours. The copper here reaches the condition of *calcined coarse metal.*

4. *Oxidation and removal of the iron.* To the product of the former operation are added certain copper ores free from sulphuret of iron. By melting in connection therewith, the sulphuret of iron is oxidized and passes into the slag, while the copper becomes a *matt*, in the condition of *white metal.* The charge is six hours in the furnace.

5. *Remelting and refining the matt.* By the application of heat in a furnace the reactions of the former operations are repeated; disengaging sulphurous acid, setting copper free to unite with the *matt*, and removing iron, which passes from the condition of sulphuret to an oxide and passes into the scoriæ.

The product is known as *blue metal.*

6. *Remelting of slags.* The slags resulting from operations 4, 7, and 8, are mixed with certain other ores in a furnace, and several chemical reactions take place, which result in two metallic products for future operations, — *red* and *white* metals.

7. *Refining of the blue metal.* The *blue metal* of operation 5 is slowly calcined, and then fused at a high temperature, the first part of the operation taking 8¼ hours, and the second 2½ hours. The reactions are to some extent repetitions of the former, and the product is *white metal.*

8. *Refining of former metallic products.* The *white metal* of operation 7, and the *red* and *white* metals of operation 6, are calcined and then refined, producing a rich *regulus* of copper, a rich slag, and bottoms.

9. *Combining and refining of former metallic products.* The *white metal*, *regulus*, and *bottoms* of former operations are calcined and fused, some rich ore being added. The product is metallic copper and a rich slag, which goes back to the operation 4. The product is known as *coarse copper.* It is run into pigs. Time required, 24 hours.

10. *Converting the coarse copper into malleable.* The *coarse copper*, in the form of pigs, is placed in the furnace; about 21¾ hours being employed in bringing it to that condition where the slag on the surface containing the metallic oxides is skimmed off. It is then called *dry*, and is in a condition which would be brittle, were it withdrawn. It is rendered malleable by carbonizing, charcoal and green wood being thrown on the surface. It is then ladled out and poured into molds.

Cop'per-plate En-grav'ing. A very ancient art; in chasing or enchasing — that is, carving on metal — it is seen in all the regions of antiquity, in the ages of copper and bronze, before iron was used. Many thousands of years passed before the plates ornamented by the graver were used for printing, and even then it was suggested by taking proofs of inlaid or chased work. An artist would take impressions of his work for purposes of transfer or reference, and from these came the suggestion of making the engraving in such a manner that the impression itself might be beautiful and worth keeping for its merits, other than as a workman's copy.

In copper-plate engraving the lines are etched, or cut by a graver in a plate; then filled with an ink; the surface of the plate wiped clean; the paper laid upon the surface of the plate, and both run through a roller-press, by which the ink is transferred to the paper.

Vasari ascribes the invention of engraving on copper to a goldsmith of Florence named Maso Finiguerra, about 1460. The oldest engravers whose names and marks are known were Israel de Mecheln, of Bokholt, in the bishopric of Munster; Martin Schoen, of Colmar, in Alsace, where he died 1486; Michael Wolgemuth, of Nuremberg, the preceptor of the famous Albert Durer.

Cop'per-plate Print'ing-press. This press is for obtaining impressions from sunken engravings; that is, those in which the design is cut *into* the copper or steel plate, in contradistinction to such as have the design salient, as in wood-engravings, where the part which is not designed to print is cut away.

In copper or steel plate engraving, lines are made in the plate by the graver; by the etching-point, followed with acid; by the etching-point alone (called dry point); and by the diamond point of the ruling-machine, followed with acid.

These lines in the plate, whether fine or heavy, are filled with ink, and the plate is then passed through the press, delivering the impression upon the soft, damp paper above it, the ink adhering to the paper and being withdrawn from the lines of the plate.

To describe the process a little more at length: The plate is laid on a small metallic table heated by a brazier beneath. This is to warm the ink, which is made very thick, and is laid on with a dabber or

roller until the lines are all full and the surface covered. The surface of the plate is then wiped off with a cloth, leaving the ink in the lines. This requires dexterity, and the plate is first wiped in one direction and then in another. The bare hand, slightly dried by a little whiting, is then applied to the plate to polish the surface, and, the margin being wiped clean, the plate is laid upon the traversing bed of the press.

The paper for the impression is then laid on the plate, and the workman turns the roller by means of the spokes, drawing the plate and paper between the bed and roller, subjecting it to heavy pressure, and causing the ink to adhere to the paper and leave the lines of the plate. Blankets intervene between the paper and the roller.

When an "India proof" is to be taken, the sheet of fine India paper is first laid on the inked plate, and the *backing* of paper is roughened by dabbing it with the bristles of a stiff brush. It is then laid on the India paper, and the pressure causes the two papers to adhere.

The old-fashioned copper-plate press has a roller moved by the radial handles, and a bed traversing on anti-friction rollers. A great improvement consists

Fig. 1445.

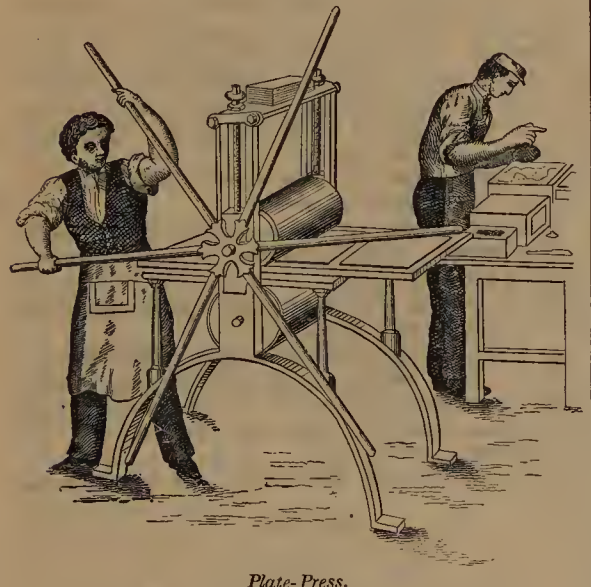


Plate-Press.

in the D-roller, which has one flat side, and allows the bed and plate to return by a counter-weight after passing beneath the periphery of the roller. A farther improvement is the heater in the bed-plate.

The Dutch, Germans, and Italians have contended for the honor of the invention of this press, but it has been awarded to the Italian sculptor and goldsmith, Tomasso Finiguera, a Florentine, who lived about 1460. It is stated to have been suggested to him by the appearance of the impression derived by the accidental pouring of a quantity of brimstone upon an engraved plate, probably engraved for the ornamentation of furniture or some implement or article of *virtu*. The first copper-plate presses were simple pressure. The rolling-press was invented in 1545.

Cop'pin. (*Spinning.*) A *cop* (which see).

Cop'ping-plate. (*Spinning.*) The copping-rail of a throstle-machine.

Cop'ping-rail. The rail or bar upon which the *bobbins* rest in the *bobbin-and-fly* or the *throstle* machine, and by whose up-and-down motion the rooving or yarn is evenly distributed. See Bobbin-and-fly Frame, or Throstle.

Cop-tube. (*Spinning.*) The tube in a spinning-machine on which the conical ball, or *cop*, of thread or yarn is formed.

Cop'u-la. (*Music.*) The stop which connects the manuals, or the latter with the pedals.

Cop'y. 1. A size of writing-paper measuring 20 × 16 inches.

2. Matter for printing.

Cop'y-hold'er. A clasp to hold matter while being set up.

Cop'y-ing-in'stru-ment. A tracing-instrument, or one for multiplying by manifold process.

A silhouette-machine is one for giving, on a reduced scale, the outline of a shadow-portrait.

A photograph is used for copying drawings on a changed scale.

Another mode is by taking an impression on a web of india-rubber, and then stretching it to the desired extent; or else stretching it and taking the impression, and allowing it to contract to the desired extent. In either case the impression may be transferred to the stone by the proper processes.

Cop'y-ing-ma-chine'. A Copying-press (which see).

Cop'y-ing-pa'per. Thin, unsized paper, used damp, for taking impressions from writings in a copying-press.

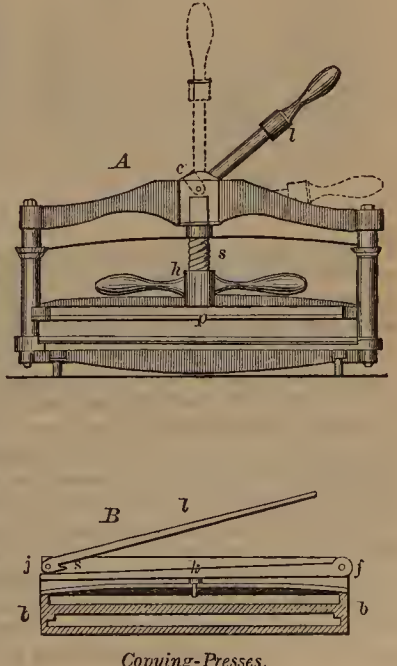
Cop'y-ing-press. A machine for taking a copy of a writing by pressure.

The usual system is to write with an ink having a somewhat viscid character, and to expose the written page to pressure in contact with a leaf of bibulous paper.

One of the first suggestions in this line was by Benjamin Franklin, who sanded the yet wet ink of the manuscript, passed it between rollers in contact with a polished soft-metal plate, imbedding the emery in the pewter so as to leave an impression from which a copy may be obtained by the copper-plate printing process.

James Watt, about 1780, adopted the plan of pressure of a page of bibulous paper against the damp manuscript, the writing being legible through the thin copying-paper.

Fig. 1446.



Copying-Presses.

Ritchie's copying-press A has formed the model for most of its class, having a bed, a platen, and a cam-lever.

The book containing the manuscript in contact with a damp page, is placed on the bed, and the platen *p* brought down by the rotation of the nut *h*, which traverses the screw *s*. An effective pressure is then brought to bear upon the screw and platen by the oscillation of the lever *l*, whose cam *c*

bears upon the upper end of the screw-shaft, and gives sufficient power to deliver the impression.

BRUNEL'S *copying-press B* acts on the compound-lever principle. The bottom of the press *b* receives the book, and the platen, being laid thereon, is driven down by the pressure of the central stud *k*, which is beneath the lever hinged at *f*.

A second lever *l*, hinged at *j*, and having a cam *s* at the end, is then brought to bear upon the former lever, giving a force equal to the delivery of an impression from the damp ink of the manuscript upon a sheet of thin bibulous paper laid thereon and backed by a damp sheet.

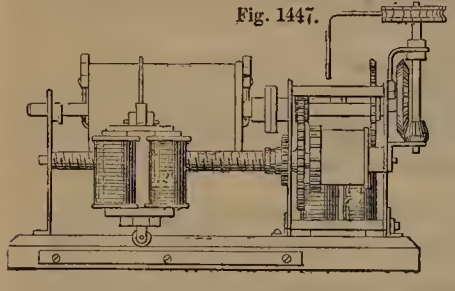
Other modes of copying are found.

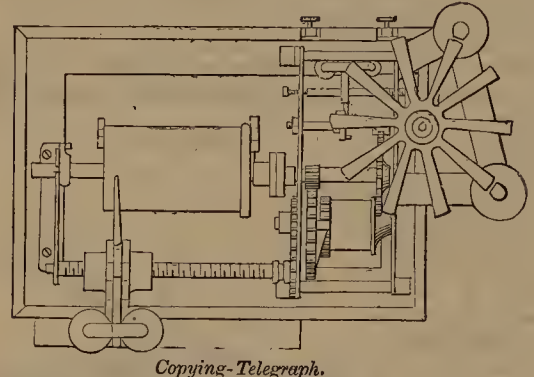
The *manifold writer*, invented by Wedgwood, 1806, and consisting of colored sheets alternating with thin paper, and giving a number of identical impressions by the action of a stylus.

Hawkins's polygraph, in which several pencils are carried in a frame, each obeying the action of a principal and writing upon its own particular sheet of paper.

Cop'y-ing-tel'e-graph. An apparatus for automatic telegraphy known as Bonelli's telegraph. The apparatus consists of a dispatching instrument and a receiver at the respective ends of the line.

Fig. 1447.





Copying-Telegraph.

The message is written with a non-conducting ink on a sheet of foil, which is then lapped aronnd the roller, and a sheet of white paper is wrapped on the receiving roller and covered by a sheet of transfer-paper. The electric circuit being established, so long as the point of the lever of the dispatcher is in contact with the metallic surface of the paper, the armature of the receiver is attracted by its magnet, and the stylus of the receiver elevated. When the stylus of the dispatcher crosses the non-conducting ink, the circuit is broken, the stylus of the receiver drops upon the transfer-paper and imprints a mark upon the paper beneath. Bonelli's had five styles and as many wires; the former trailed over the line of letters, making five simultaneous impressions, which gave dotted skeletons of the letters, the points being sufficiently numerous and proximate to enable the letters to be readily distinguished. Instead of the ink of transfer, chemically prepared paper has been used, which was acted upon by the spark, giving visible dots at the points of chemical reaction.

Cor'a-cle. A form of canoe used in Egypt and in Britain from the earliest periods of history. It consists of a light wooden frame covered with hides, and capable of being carried on the shoulders. The coracle is still in use in the West of England, Wales, and in some parts of Ireland.

Fig. 1448.

Coracle.

The same kind of boat is yet used upon the river *Bo-Tchou*, in Thibet, as mentioned by the Abbé Huc, in his "Travels in Tartary and Thibet," 1844–46. "It was composed of ox-hides, solidly sewn together, and kept in shape by some light triangles of bamboo. . . . . The man then took his boat again upon his back, and rode off."

The birch-bark canoe differs mainly from this in the material wherewith it is covered. See CANOE.

Cor'bel. (*Architecture.*) Or *corbeille*. A form of bracket used in Gothic architecture to support the ends of timbers, arches, parapets, floors, cornices, etc. It is a projecting block of stone, usually carved, and with a receding face.

Cor'bel-piece. A bolster, a wooden supporting piece or bracket. A *corbel*.

Cor'bel-ta'ble. A cornice supported by corbels.

Cor-bond'. (*Mining.*) An irregular mass or dropper from the lode.

Cord. 1. A string or small rope composed of several strands twisted together.

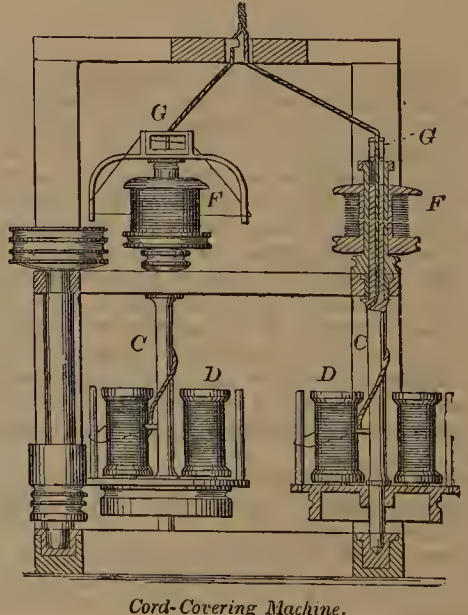
2. A kind of stout ribbed fustian; *corduroy*.

3. In fancy weaving, the space of the design-paper confined by two vertical lines, also the string which connects the *neck-twines* at the *leaf*.

Cord'age. See ROPE.

Cord-cov'er-ing Ma-chine. A machine in

Fig. 1449.



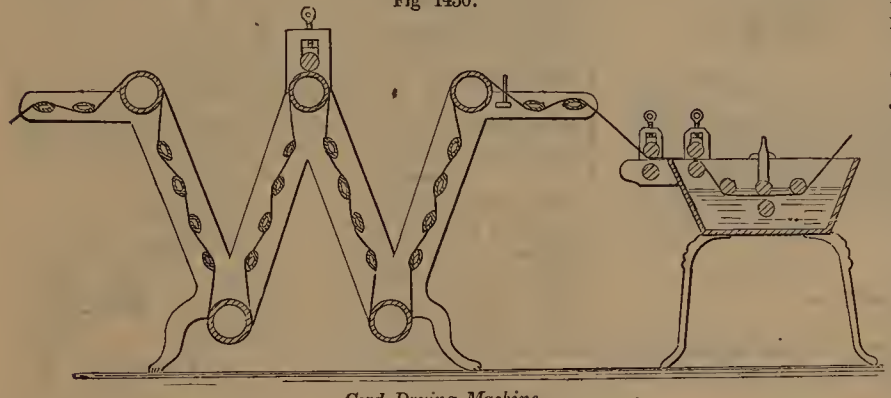
Cord-Covering Machine.

which a cord (or wire) receives a covering of thread or silk; when this is plaited on, it constitutes braiding. (See BRAIDING-MACHINE.) In the machine represented, the yarn-bobbins *D D* are upon carriers, and the yarn proceeds upwardly through the spindles *C* and the flyer-bobbins *F*, which are sleeved thereon and carry the silk, which is twisted by the flyer around the yarn or cord from the spool *D* at a point below where it issues from the guide *G*. At a point above, the three covered yarns are twisted into a threefold cord or bullion.

Cord-dry'er. A machine for drying sized or dyed cords, webbing, tapes, etc.

The stuff passes beneath rollers submerged in the liquid of the tank, thence beneath pressure-rollers, which remove superfluous moisture; then between flattening rollers, thence to the dryer, which has a series of parallel pipes placed in slightly inclined

Fig 1450.



Cord-Drying Machine.

ranges; the material to be dried passing up and down, being interlaced between the pipes. Hollow, heated cylinders, around which the fabric passes, are placed between the ranges.

Cord'ed Fab'ric. One having a pile which is cut in ribs in the direction of the length of the warp, as corduroy.

One having alternate larger and smaller threads, either in the weft or the warp, so as to give a ribbed or corded surface.

Cord'er. (*Sewing-machine.*) A device for laying cords between fabrics, or cords or braids on the surface of a fabric. See "Sewing-Machine Attachments," published by G. W. Gregory, Washington, D. C.

Cor-dil'las. (*Fabric.*) A kind of kersey.

Cord'ing. (*Weaving.*) The *cording of a loom* is the arrangement of the heddles so that they move in such clusters and times as may be required for the production of the pattern. (See DRAFT.) A set of heddles connected with a given shaft is called a *leaf*. Each shaft is connected by a *cord* to the treadle whereby it is moved.

Cor'don. 1. (*Fortification.*) The coping of the revetment of the *scarp*, which is the inner wall of the ditch. At this point the *fraise* is placed, if such be used.

The *cordon* projects a foot beyond the face of the *scarp*, or *revetment*.

2. The edge of a stone on the outside of a building.

Cor'do-van; Cord'wain. A Spanish leather, originally of goat-skin, but now frequently made of split horse-hides. It is finished as a black morocco, and is named from Cordova (the ancient *Corduba*), which is situated on the Guadalquiver, in Andalusia, and was founded by Marcellus. It was the chief emporium of Iberia. The Moorish city contained 300,000 inhabitants in the eighth, ninth, and tenth centuries. It was the great seat of the arts, sciences, and learning in the days of liberal Spain, when the people were worth something, before the black darkness of the Pedros and Philips.

Cor-du-roy'. 1. (*Fabric.*) A stout, ribbed cotton fustian, made with a pile so cut as to leave a surface ridged in the direction of the warp.

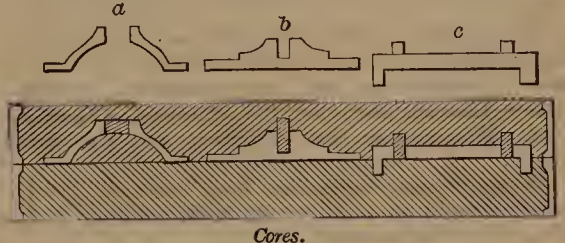
2. A road formed of poles laid transversely and in contact. It is used as a mud-bridge in swampy places.

Core. 1. (*Founding.*) An internal mold which forms the interior of a cylinder, tube, pipe, faucet, or other hollow casting. It is made of various proportions of new sand, loam, and horse-dung. It requires to be thoroughly dried, and when containing horse-dung must be burned to a red heat, to consume the straw. This makes it porous and of a brick-red color.

The core is made in a *core-box*, and has projecting portions, known as *core-prints*, which rest in the *prints* of the mold. The model from which the object is cast is solid, and makes an impression, partly in the cope and partly in the drag. When the pattern is removed, the core is laid in its place, the projecting portions resting in the recesses made by the *prints* of the pattern. Touching the loam of the mold at no other point, it occupies, in the case of a pipe, a central position in the space which is to be run full of metal. When the metal has been poured around it and then cooled, the core is broken out, leaving the casting hollow.

Simple cores are those which do not prevent the *delivery* of the cope and drag, that is, which have

Fig. 1451.



Cores.

no undercut portion which would prevent the portions of the flask from being *parted* in the usual way.

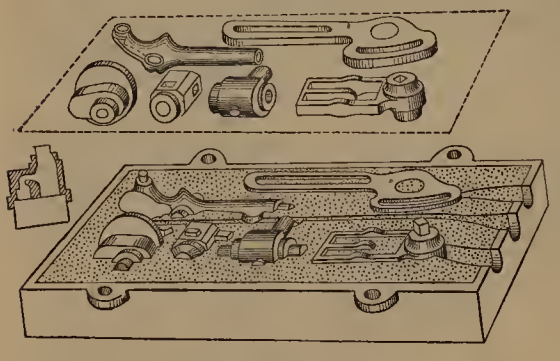
In the first of the examples represented (*a*), the core is inserted in the pattern when molding, and is pushed from the pattern so as to remain in the mold when the pattern is withdrawn.

In the second example (*b*), the portion of the core projecting from the pattern forms a *print*, and both pattern and core are molded together. When the pattern is withdrawn, the core is detached and the *print* inserted in the impression made by it in the cope. That part of the core which was imbedded in the pattern then projects into the space, and the metal is cast around it. The core thus makes a hole *in* the casting, but not *through* it, as will be observed.

In the third example (*e*), the pattern has projecting pieces, called *prints*, on one or both sides; when molded, these projections make holes in the loam. Cores of the required size and shape, and having projections to fit these holes, are previously made, and, being fitted thereinto, are secured thereby, the portions projecting into the open space being surrounded by the metal, so as to make a hole in the casting or a hollow casting, as the case may be, when the core is picked to pieces and broken out of the metal.

The example of patterns and cores shows several arranged in one flask. In one figure, the *ingates* and *runners* are prepared and the cores in their places,

Fig. 1452



Patterns and Cores.

being shaded for distinction. In the upper figure, the articles are in their ultimate shape, with holes in them.

The group includes a stopcock with a cruciform core, which forms the duct and the hole for the spigot. A piece having a straight and a curved mortise, and which delivers its own core. One having only a perpendicular, square core. One with a round core parallel with the face of the flask. One having two rectangular cores crossing each other at right angles. The cap of a double-acting pump, the core for which is shown in section in the small figure; the shaded portions being the metal.

Sheaves are cast with annular cores, the pattern being divided in a plane perpendicular to its axis, which permits one half the pattern to be withdrawn, then the core, then the other part of the pattern. The core is then replaced, and the mold closed.

When a core is made on a large scale, as in the interior mold of a heavy cylinder, cistern, tank, etc., it is called a *nowel*.

2. A central piece occupying an axial position within a circular aperture at which clay or lead exudes in the process of making earthenware or leaden pipes. The core gives the inside shape to the pipe.

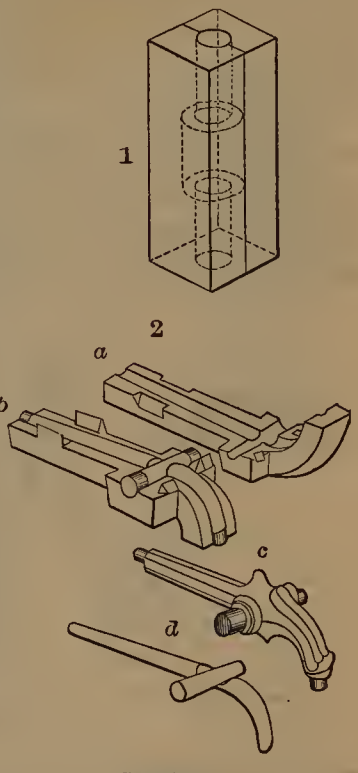
3. (*Rope-making.*) The central strand around which four other strands are twisted in a *shroud hawser-laid* rope.

4. (*Hydraulic Engineering.*) A wall or structure absolutely impervious to water, placed in an embankment or dike to prevent the percolation of water, which may penetrate the porous material of which the remainder of the dike is composed. The core may be of puddle or a wall laid in hydraulic cement.

Core-bar. The bar or spindle which supports the core of a shell.

Core-box. A divisible box in which clay is rammed to form cores. For cylindrical cores, as in the example 1, it divides through the axis, each portion having a recess which is equal to one half of the core to be molded therein. These portions are united by dowel-pins, and held together by clamps while the sand is rammed into them.

Fig. 1453.



Core-Boxes.

The examples (2) represent: —

a b the two halves of a brass or lead *core-box* suitable for casting the stopcock *c*; *d* shows the core itself after its removal from the core-box *b*, in which it is also shown. *c* is the model from which the object is molded; the shaded parts represent the projections or core-prints, which imprint within the mold the places where the extremities of the core *d* are supported when placed therein.

Core-box Plane. A peculiar form of plane which has a cutting tooth projecting below the sole, to plow grooves in the parts of a core-box.

Core-print. A projecting piece on a pattern for molding, to form a hole in the mold to receive the end of the core by which it is sustained in the mold in proper position relatively to the object cast. (See *c*, Fig. 1453.)

Cor'er and Sli'cer. An implement for cutting the core out of a peeled apple, and at the same time cutting into pieces for cooking or drying. (See Fig. 281.)

Core-valve. A plug-valve which has a rotary reciprocation in a cylindrical or hollow conical seat; occupying about the same relative position to its seat as the core of a faucet does to the casting itself.

Co-rec'tome. *Coretome.* An instrument for cutting through the iris to form an artificial pupil. An *iridectome* (which see).

Corf. (*Mining.*) 1. A basket to carry coal or ore. A *corve*.

2. A square frame of wood to carry coals on.

3. A sled or low-wheeled wagon in a mine, to convey coal or ore from the miners to the bottom of the shaft.

Cork. The bark of the evergreen oak (*Quercus suber*). It grows in the South of France, in Tuscany, Spain, Portugal, and Algeria. The tree sheds its abundant bark naturally, but this produce is valueless commercially.

The cork-tree at the age of twenty-five years is barked for the first time. A circular incision is first made through the bark near the ground, and another, also around the tree, close by the branches. These cuts are followed by others equally deep, made longitudinally, and dividing the bark into broad planks. The tree is then left: the sap has been stopped from circulation; the bark begins to dry and curl outward; and shortly each strip is peeled

off by the hand. This process is repeated every ten years. Thus gathered, this bark is prepared for market in two ways. By one method, the *tables*, as they are called, are heaped one upon another, their concave sides being undermost, in deep trenches, and, being plentifully moistened, are pressed beneath huge bowlders till thoroughly flattened out. They are then dried carefully before large fires, and turned constantly. When perfectly flat and dry, they are complete.

By the second method the damp pressure in the pits is dispensed with, the *tables* being simply laid with their convex sides toward the fire, and suffered to remain until their warp is lost and they become flat. This tree and its uses were known to the Greeks and Romans. In the time of Pliny it was employed for nearly as many purposes as at present; as floats for fishermen's nets, waterproof soles for shoes, buoys for anchors, and for swimming-jackets. The use of cork for stopping bottles was not entirely unknown to the Romans, being mentioned by Cato and Horace, though its application to this purpose does not seem to have been very common, as we find everywhere directions given to close up wine-casks and other vessels with pitch, clay, gypsum, or potter's earth, or to fill the upper part of the vessel with oil or honey, in order to exclude the air from those liquors which they wished to preserve.

Stoppers of cork seem to have been first introduced after the invention of glass bottles, and these do not appear to have come into use before the fifteenth century. When Stephanus wrote (in 1553), cork was used in France principally for soles; and in Germany wax stoppers were used by the apothecaries until about the close of the seventeenth century,

Where the tree is indigenous, the inhabitants apply cork to many purposes. In Spain, beehives and kitchen pails, pillows and window lights; in Morocco, drinking-vessels and plates, tubs and house-conduits; in Portugal, roofs for houses, lining for garden-walls, and fences for poultry-yards; in Turkey, cabins for the cork-cutters and coffins for the dead; in Italy, images and crosses, pavements along the *via crucia*, and buttresses for the village churches; in Algeria, shoes and wearing-apparel, saddles and horseshoes, armor and boats, landmarks and fortifications, furniture in mansions, racks in stables, and steps for houses. Its use for floats, shoe-soles, wads for howitzers, bungs, stoppers, hat foundations, life-boats, models of architecture, and as a material for Spanish black, are familiar to most of us.

Cork-clasp. A wire attached to the neck of a bottle, and holding down the cork. See BOTTLE-STOPPER.

Cork-cut'ter's Knife. The knife of the cork-cutter has a very thin and sharp blade about six inches long and tapering, with a truncated end. It is constantly whetted upon the board from which rises the stake on which the cork rests during cutting.

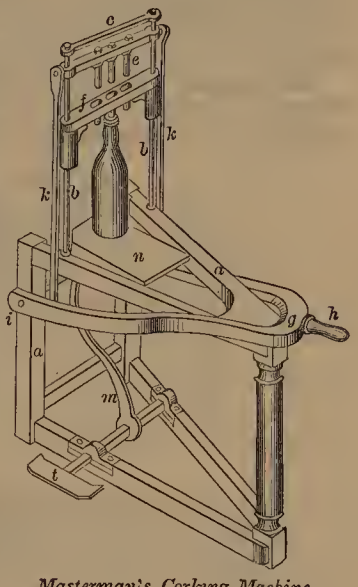
Fig. 1454.

Cork-Cutter's Knife.

Cork-fau'cet. One adapted to be inserted through a cork, to draw the contents of a bottle. See BOTTLE-FAUCET.

Cork'ing-ma-chine'. One for driving corks into bottles. *a* is the frame; *b b*, two vertical guide-rods connected at top by the bridging-piece *c*. A cross-head sliding on the upper ends of the guide-rods *b b* is connected by side-rods *k k* to the lever *g*, the branches of which have their fulcrums at *i*, and are united at the handle *h*. In the cross-head are secured three metallic plugs *e*, immediately above the holes in the cross-piece *f*, which is firmly secured to the guide-rods *b*. In the cross-piece *f* are three conical tubes of different sizes, so as to suit the varying necks of bottles of different sizes. The upper ends of the tubes are larger than the lower ends, through which the corks are forcibly driven. *n* is a wedge-shaped piece whose upper surface is horizontal, and it is moved to and fro in slides by means of the treadle *t* and arm *m*.

Fig. 1455.



Masterman's Corking-Machine.

The operation is as follows:—

The workman seats himself at the machine, one foot on the treadle, and the handle *h* in his right hand. He places a bottle on the wedge *n*, with its neck beneath such one of the three tubes as will contain a cork of the size he sees to be suitable. Such a cork being placed in the tube, a motion of the treadle raises the bottle, and the depression of the lever *h g* drives the cork into the neck of the bottle. The reverse motions of the lever and treadle release the bottle. See BOTTLING-MACHINE.

Father Penguin, a monk of the monastery of Hautvilliers (died in 1715), seems to have been the inventor of sparkling champagne. The wine of the country had been celebrated for centuries, but the old Benedictine discovered the art of making it effervescent, and secured it by a *cork* and *string*.

Cork-fast'en-er. See BOTTLE-STOPPER.

Cork-jack'et. A jacket lined with cork for the purpose of sustaining the wearer on the surface of the water. The Roman whom Camillus sent to the capitol when besieged by the Gauls is reported to have supported himself by a cork-jacket as he swam the Tiber with his clothes on his head.

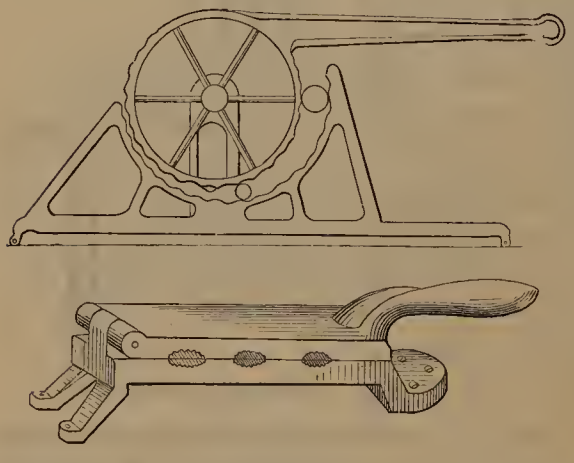
Cork-ma-chine'. Corks are made by hand and by machinery. The former readily but slowly produces the perfectly shaped, somewhat tapering cork; the latter process produced a cleanly cut cork, usually of cylindrical form, the tapering form being afterwards given by pressure. In hand-making, the workman, with a sharp knife in his hand, and a block of cork in his left, forms the cork by two semi-circular cuts. In the machine, the knife cuts a perfect arc; the machine drops the cork into one receptacle and the shavings into another, and the hone instantly sharpens the knife for farther work.

In another form of machine, the slabs are cut into square blocks by a circular knife mounted like a circular saw. The square pieces are then held by the hands of boys in a kind of lathe, in such a position that the sharp and thin end of a hollow cylindrical cutter will cut out a perfectly round cork in an instant. Cutters of various sizes are employed to cut corks of the desired size. Each cork is then placed by little fingers in corresponding recesses, in a feed-

wheel of an automatic machine, where the corks are tapered by the removal of a thin shaving from the periphery of one end. The shaving is removed by the sharp edge of a circular cutter over two feet in diameter, which revolves horizontally. The edge of every instrument that cuts cork is brought in contact with the material to be cut with a very *drawing* stroke, as such spongy material could not be cut satisfactorily by a *crushing* stroke. Thick slabs of cork are cut into large corks, while the thin ones are worked into corks of a corresponding size.

Cork-press. One in which a cork, previously wetted, is rendered elastic, to enable it the more readily to enter the neck of a bottle. In one form,

Fig. 1456.



Cork-Presses.

the cork is placed between the serrated surfaces of the concave and the eccentric cam, and pressed to a less or greater extent by a partial rotation of the latter.

Another form is a lever press with jaws.

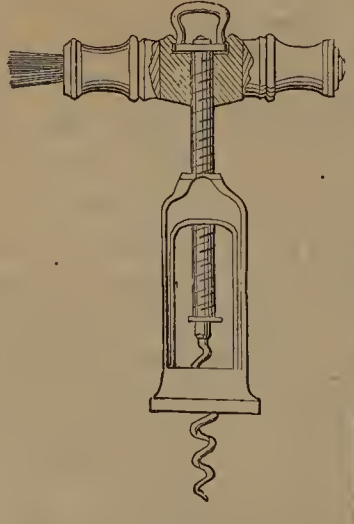
Cork-pull. A substitute for a corkscrew, having hooks or fangs which clasp a cork when in the bottle and draw it thence.

The jaws, while collapsed by the slide, are passed through the neck of the bottle ; and, being opened, are then clasped around the cork by the motion of the slide, and the cork with its retractor is drawn from the bottle.

Fig. 1457.

Cork-Pull.

Fig. 1458.



Corkscrew.

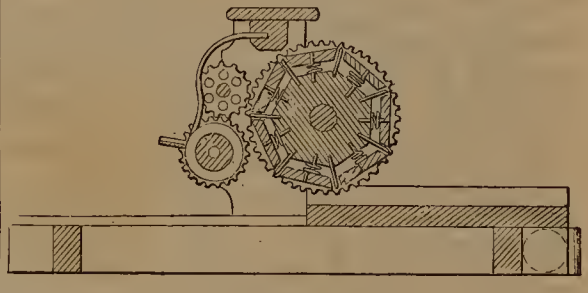
Cork'screw. The double-screw which entered the cork by rotation, and then withdrew it by a continued or reversed circular motion, was patented in England by Thomason, 1802.

Cork'screw-stair'case. A winding stairs with a solid newel.

Cor'liss-en'gine. A form of steam-engine having a variable and automatic cut-off of peculiar character. (See CUT-OFF.) It has two inlet and two exhaust valves, which are segmental, and vibrate, each on its spindle, within a bored cylindrical seat. The valves are independently moved by rods from a vibrating disk, which is operated by an eccentric and rod. The mechanism which opens the valve is thrown out of gear during every stroke of the engine. When this disconnection takes place, the valve is instantaneously closed by a spring, which is cushioned by a small piston closing on compressed air. The instant at which the steam-valves are thrown out of gear, and the steam thus cut off, depends on the position of the balls of the governor at the moment. The exhaust-valves open invariably to their full extent. See CUT-OFF.

Corn-cake Cut'ter. A stamp or form which cuts corn-cakes from the sheet of dough ; or a machine having a roller carrying said forms and cutting into shapes the sheet of dough, which is spread upon the table passing beneath.

Fig. 1459.



Cake-Cutter.

Corn-cov'er-er. A plow or pair of plows to run alongside a row of dropped corn and throw earth upon the seed. Sometimes followed by a roller on the same stock to compact the earth.

Corn-crib. A granary for corn, having openings between the slats forming the sides, to enable the crib to admit air and season the corn without molding.

Corn-cul'ti-va'tor. A plow for cultivating corn in hills or drills. See CULTIVATOR.

Corn-cut'ter. 1. (*Agriculture.*) A knife or a machine for cutting corn. See CORN-KNIFE ; CORN-HARVESTER.

2. (*Surgical.*) An instrument for removing horny excrescences from the feet.

Corn-drill. A planter for sowing corn in rows.

The corn-planter, properly speaking, places the seed in hills in a row. When the rows are *checked*, so called, the corn may be worked one way and then across, and so on. Corn in drills can be tended but one way. See CORN-PLANTER.

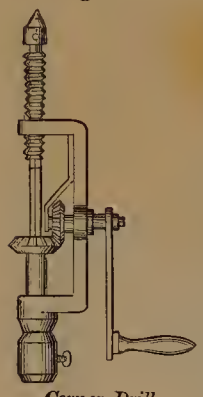
Cor'ner. (*Book-binding.*) *a.* Leather corner-covering to a half-bound book.

b. A triangular tool used in gold or blind tooling.

Cor'ner-chis'el. A chisel with two edges projecting rectangularly from a corner ; used for cutting the corners of mortises.

Cor'ner-drill. One driven by a crank and bevel gearing, being thus adapted to bore in places where

Fig. 1460.



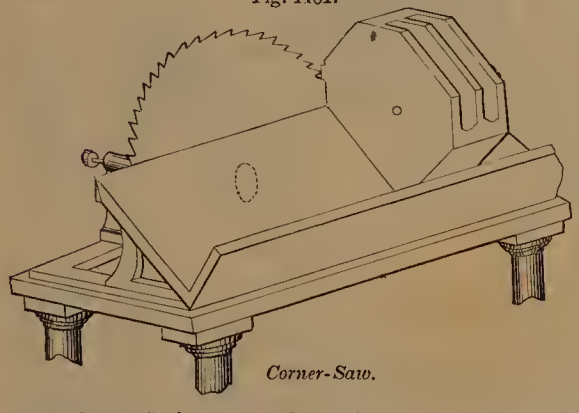
Corner-Drill.

the surrounding frame or machinery will not allow the revolution of the ordinary brace-handle. The back-center has a rigid support, and the tool is advanced by the occasional rotation of the feed-screw, by a lever-pin in the transverse hole of the screw-head. Also called a *French drill.*

Cor'ner-punch. (*Machinery.*) An angular punch for cleaning out corners.

Cor'ner-saw. One for removing the corners of a block, giving it an octagonal shape. The saw-mandrel is mounted in a head which traverses on ways parallel to the trough in which the block is placed. The block is slid in the trough, bringing it against the saw, and taking off the corners in

Fig. 1461.



Corner-Saw.

succession. It is one of the series of block-making machines.

Cor'net. 1. (*Music.*) *a.* A wooden wind-instrument of the oboe class, long since disused.

b. A metallic wind-instrument resembling a trumpet, and used in bands. The *cornu* of the Romans, like the instruments mentioned in Leviticus (xxv. 9), was curved and formed from a horn. It was afterwards of metal, probably copper. Its invention is credited by Athenæus to the Etruscans. It differed from the *tibia* in being larger, and from the *tuba* in being curved. It had no keys or stopples.

2. An auricular instrument which does not protrude beyond the external ear. It is used in cases of obstruction of the *meatus auditorius*, by reason of contraction, or the presence of polipi, and is made of gold or silver.

Cor'net-a-Pis'tons. (*Music.*) A metallic wind-instrument of the trumpet class, furnished with valves and stoppers. These instruments, under the care of Sax of Paris and Distin of London, have attained great excellence.

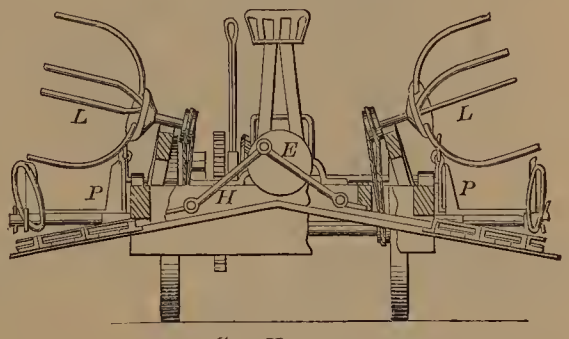
They are made of various sizes and compass, so as to embrace different parts.

Corn-grat'er. A roughened surface for rasping green corn from the cob.

Corn-harp. A Scottish agricultural implement, of the nature of a sieve, for freeing grain from the seeds of weeds.

Corn-har'vest-er. A machine for cutting corn in the field; sometimes delivering the corn in

Fig. 1462.

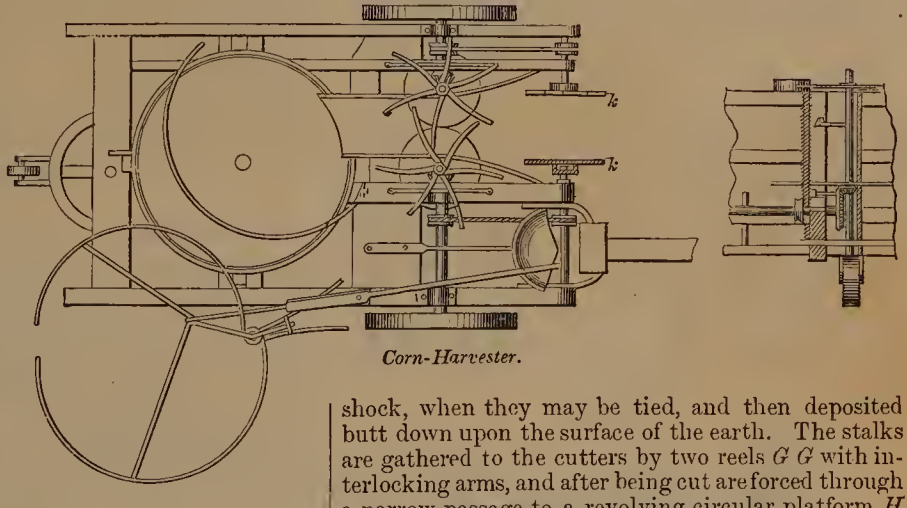


Corn-Harvester.

shocks, sometimes merely laying it in gavels upon the ground, or in a cradle on the machine, from whence it is taken by hand and shocked. Fig. 1462 shows a corn-harvester for cutting two rows at a time. The reels *L* are set obliquely, so as to gather the corn to the knives and tilt it over so that it drops into the boxes *P*, which, as soon as a sufficient amount has been thus collected, are tilted up, to discharge the gavel in a heap upon the ground. The sickle-knives are driven by the wrist-wheel *E* and pitmans *H*, by power derived through gearing from the main axle.

Fig. 1463 is a machine for cutting a single row, keeping the stalks vertical, collecting them into a

Fig. 1463.



Corn-Harvester.

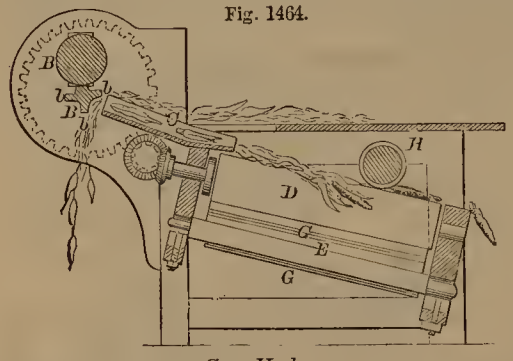
shock, when they may be tied, and then deposited butt down upon the surface of the earth. The stalks are gathered to the cutters by two reels *G G* with interlocking arms, and after being cut are forced through a narrow passage to a revolving circular platform *H* surrounded by hoops, so arranged that one half may be opened outward for the discharge of the shock; the stalks are held upright in this receptacle by a semicircular spring upon the top of the hoops. To a post upon the main frame is pivoted a lever, which operates a clasping device by which the shock is lifted for discharge. Two small reels *k k* at the front of the frame, revolving in perpendicular planes, pick up broken stalks.

Corn-hull'er. A machine for removing the

hull or cuticle from grains of corn, without powdering the same. See HOMINY-MACHINE.

Corn-husk'er. A machine for taking the ear of corn out of its enveloping sheath of leaves. Some

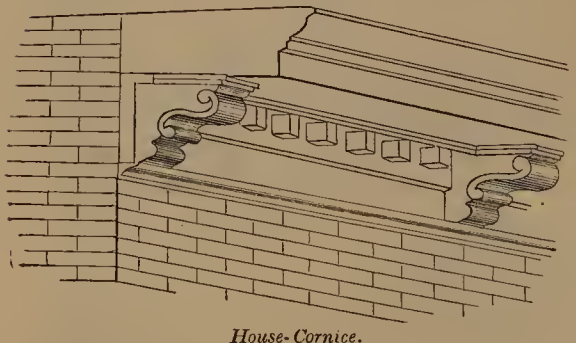
Fig. 1464.



Corn-Husker.

machines operate upon the corn in the field to husk it off the stalk; in others, the ear is simply jerked from the stalk, and the machine tears off the husks from the ears. Fig. 1464 shows one in which shocked corn is husked. The unhusked corn in the stalk is laid upon the table at the top of the machine, and pushed, butt-ends forward, between two feed-rollers *B B*, whereupon the ears are separated from the stalks by cutters *b*, arranged longitudinally upon the lowermost of the feed-rollers. The severed

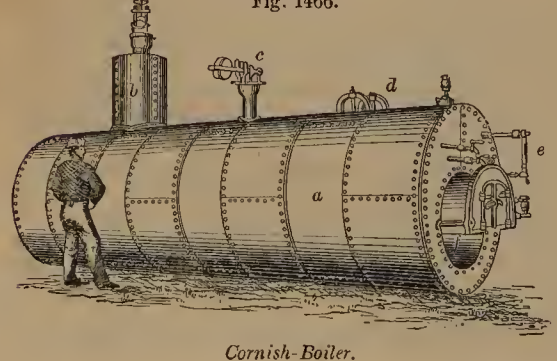
Fig. 1465.



House-Cornice.

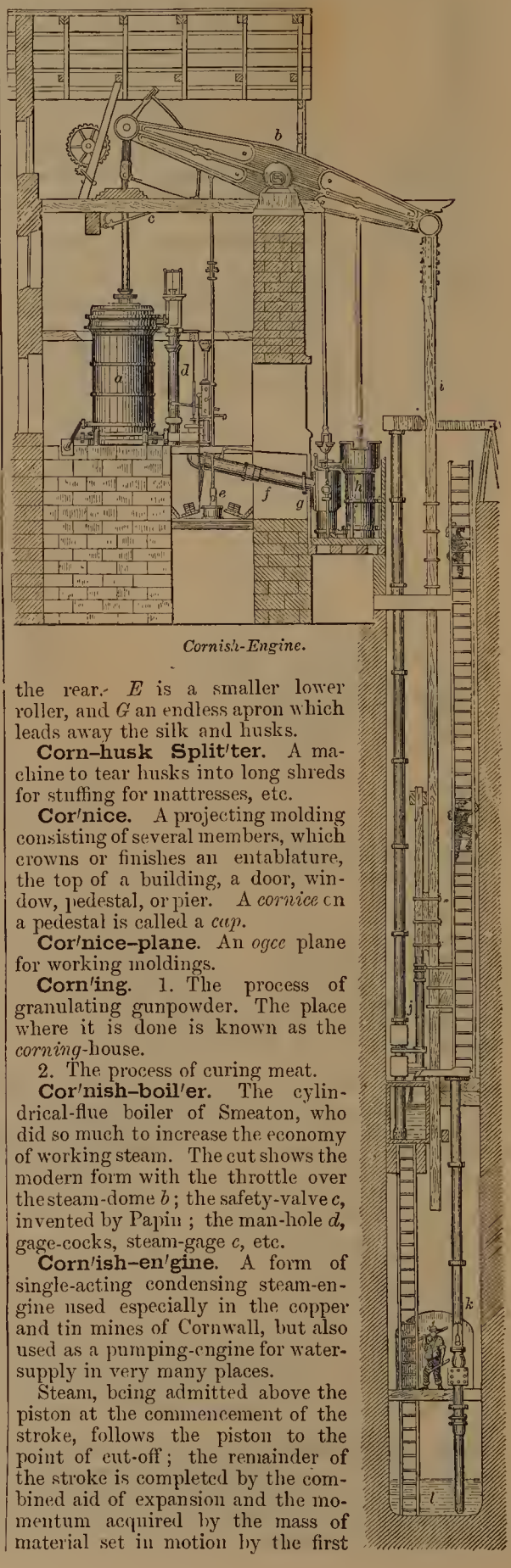
ears pass down upon an inclined plane *C*, which directs them into the trough-like space between the two individual rollers of each pair of husking-rollers *D*, and as they pass longitudinally down such space the rapidly moving surfaces of the rollers catch the husks, giving a kind of rotary movement to the ears, stripping away the husks, which latter are carried down between the rollers and ejected underneath the machine. The ears meanwhile are thrown back by a transverse roller *H*, and fall from

Fig. 1466.



Cornish-Boiler.

Fig. 1467



Cornish-Engine.

the rear. *E* is a smaller lower roller, and *G* an endless apron which leads away the silk and husks.

Corn-husk Split'ter. A machine to tear husks into long shreds for stuffing for mattresses, etc.

Cor'nice. A projecting molding consisting of several members, which crowns or finishes an entablature, the top of a building, a door, window, pedestal, or pier. A *cornice* on a pedestal is called a *cap*.

Cor'nice-plane. An *ogee* plane for working moldings.

Corn'ing. 1. The process of granulating gunpowder. The place where it is done is known as the *corning*-house.

2. The process of curing meat.

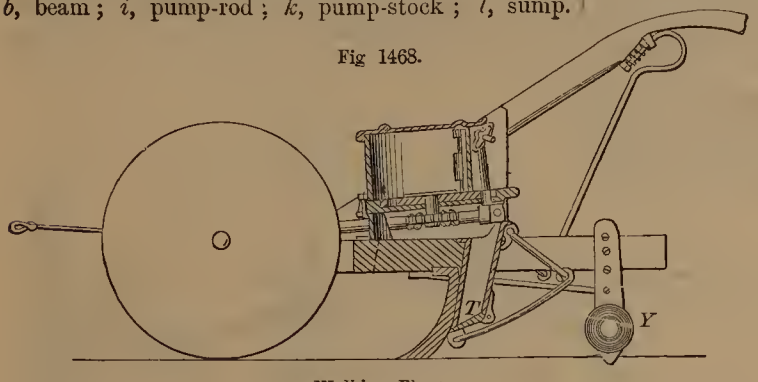
Cor'nish-boil'er. The cylindrical-flue boiler of Smeaton, who did so much to increase the economy of working steam. The cut shows the modern form with the throttle over the steam-dome *b*; the safety-valve *c*, invented by Papin; the man-hole *d*, gage-cocks, steam-gage *e*, etc.

Corn'ish-en'gine. A form of single-acting condensing steam-engine used especially in the copper and tin mines of Cornwall, but also used as a pumping-engine for water-supply in very many places.

Steam, being admitted above the piston at the commencement of the stroke, follows the piston to the point of cut-off; the remainder of the stroke is completed by the combined aid of expansion and the momentum acquired by the mass of material set in motion by the first

impulse of the steam. On the completion of the stroke, the steam is allowed to pass freely from one side of the piston to the other, producing an equilibrium of effect during the out-stroke. Before the piston arrives at the point of commencement again, the equilibrium-valve is closed, shutting in a quantity of steam before it. By means of this cushioning, which is subject to the nicest adjustment, the loss from clearance and steam-ports is rendered practically nothing, if the steam so compressed be equal to the initial pressure. The piston is thus gradually brought to a neutral state at the end of the stroke, when the exhaust-valve opens a communication by pipe *f* between the lower end of the cylinder *a* and the condenser *g*. *e* is the cataract; *b*, beam; *i*, pump-rod; *k*, pump-stock; *l*, sump.

Fig 1468.



Walking-Planter.

The great care and systematic mode of reporting the duty of the engines of Cornwall has enabled a more careful review to be made in respect to the gradual improvement of the steam-engine than has been afforded by any other description of engine. See DUTY.

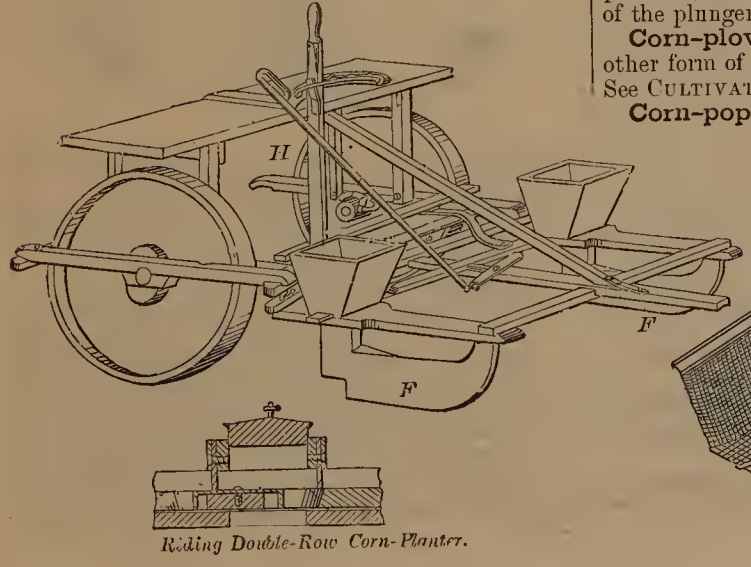
Corn-knife. A blade about twenty inches long, attached by a tang to a handle, and used for cutting standing corn. It resembles the cane-knife or machete, and is used for a similar purpose.

Corn-mill. A farm or plantation mill, usually of iron both as to its runner and the concave, and used for rough-grinding corn on the cob for stock.

Cor-no'pe-an. (*Music.*) A kind of cornet with valves.

Corn-plant'er. A machine for dropping corn in hills, previously opening the ground for the reception of the seed, and subsequently throwing back the earth and rolling it flat.

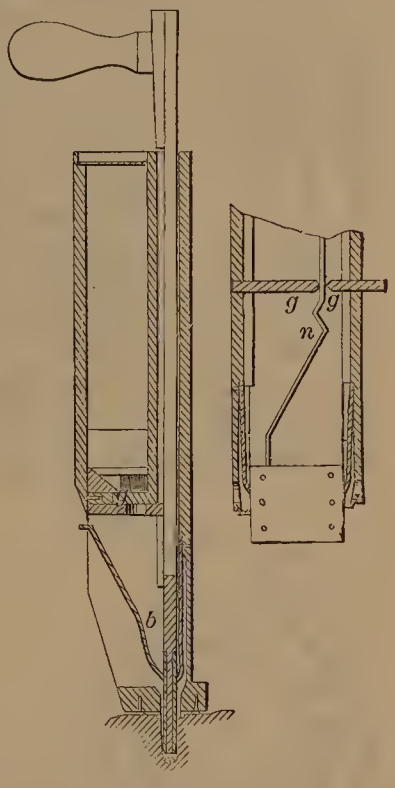
Fig. 1469.



Riding Double-Row Corn-Planter.

Fig. 1468 shows a corn-planter used like a plow; a man follows and operates the seed-valve *T* by a hand-trigger. A rotating pocketed disk in the adjustable hopper is rotated at varying speeds by a worm on the shaft rotated by a pinion engaging with one or another of the gear-wheels on the main shaft. The share opens the furrow, the roller *Y* covers the seed.

Fig. 1470.



Hand-Planter.

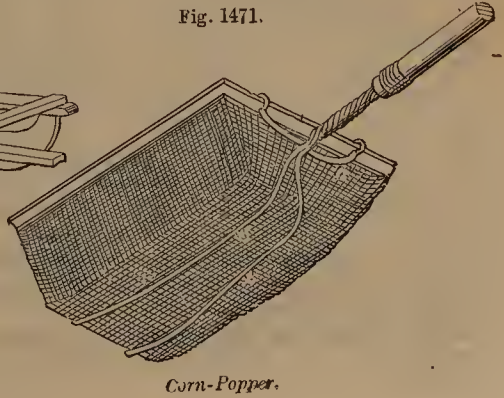
Fig. 1469 is arranged to plant two rows at once, the operator riding on the machine and working the seed-slides by a lever, or allowing them to be worked by a cam driven by the axle, as may be desired. The sled-runners *F F* open the furrow; by a motion of the upright lever *H* the planting part may be lifted clear of the ground, resting on the tongue and wheels in going from field to field or turning at the ends of the rows.

Another form is a hand-planter, which is thrust into the ground. The downward motion of the plunger drives the seed into the ground. The upward motion operates the seed-slide *g g* by the zigzag *n*, and deposits another bunch of grains in the pocket *b*, ready to be thrust out by the next descent of the plunger.

Corn-plow. A shovel-plow, double-shovel, or other form of plow for tending crops planted in hills. See CULTIVATOR.

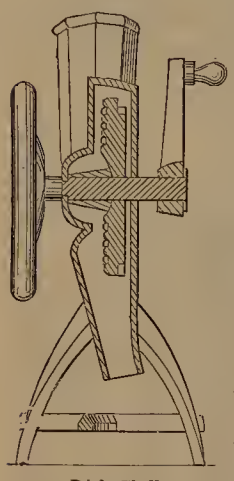
Corn-pop'per. A wire basket in which pop-

Fig. 1471.



Corn-Popper.

Fig. 1472.



Disk-Sheller.

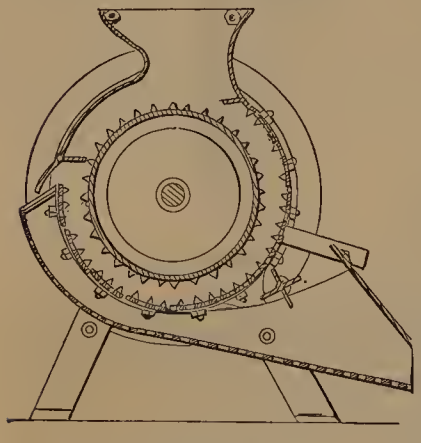
corn is heated till the hull cracks open and allows the starchy follicles to expand.

Corn-row Mark'er. A sled with a gaged width between the runners for marking out rows in which to plant corn. It has an outrigger, which scratches the ground at another gaged distance, as a guide for the next trip. The process is repeated at right angles to the former markings, and the intersections of the marks are the places for dropping the seed.

Corn-shell'er. The *corn-sheller*, for rubbing the grains from the cob, is made in various forms.

1. The roughened or toothed disk (Fig. 1472), which operates upon the ears in connection with a chute or oblique pressure-board, which holds

Fig. 1473.

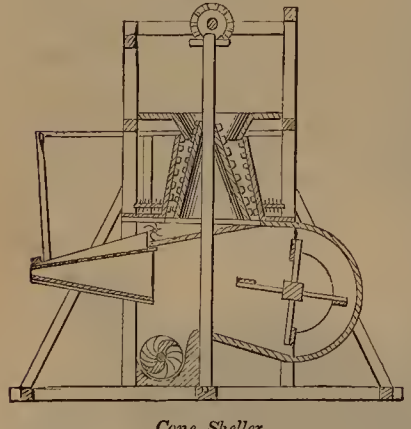


Cylinder-Sheller.

the corn against the rubber.

2. The cylinder (Figs. 1473 and 1474) with toothed periphery acting upon the ears in connection with a concave, which affords a gradually decreasing throat as the ears roll and rub and part with their grains.

Fig. 1474.



Cone-Sheller.

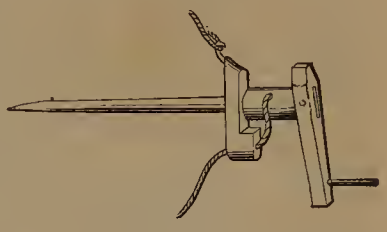
3. An orifice into which the ear is driven by a blow from a mallet, driving the cob through and shelling off the grains.

Corn-shock Ty'er. An implement for straining a band around a shock of corn, to facilitate tying. The pin is thrust into the shock, and one end of the band fastened to one part, while the other end of the band is wound upon the axis.

Corn-shock'ing Ma-chine'. A machine for cutting corn in the field and binding it into shocks.

Corn-stalk Cut'ter. A machine for gathering the dry corn-stalks of a previous year's crop into rows, and cutting them into short pieces, so that they may be covered in by the plow.

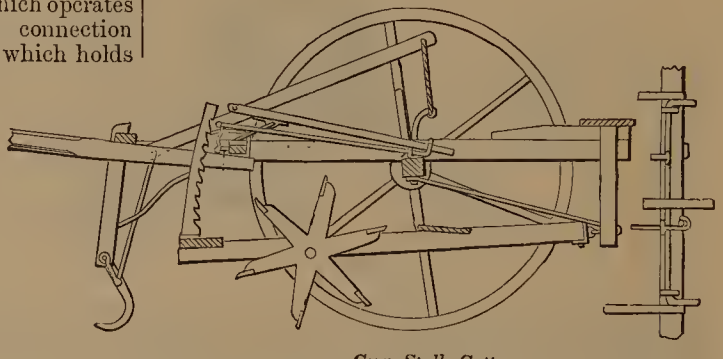
Fig. 1475.



Corn-Shock Tyer.

The hooks, attached to hanging-posts, are in the advance, and are maintained in position by certain devices. Their duty is to straighten out the corn-stalks parallel with the line of motion of the machine. The rotating cutter-wheel has its bearings in a vertically adjustable frame.

Fig. 1476.

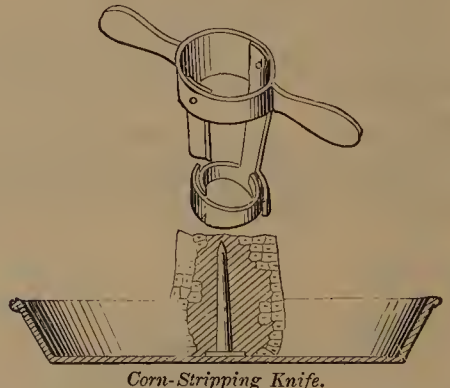


Corn-Stalk Cutter.

Corn-strip'ping Knife. A knife for cutting green corn from the cob for cooking or canning.

The roasting ear is erected upon a spike in the

Fig. 1477.



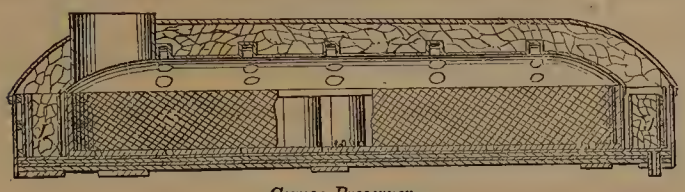
Corn-Stripping Knife.

dish; the corn is stripped from the cob by a handled cutter with curved, lapping spring blades.

Co-ro'na. (*Architecture.*) A broad, projecting face forming the principal member of a cornice. The soffit is *throated*, so as to form a drip edge.

Corpse-cool'er. A temporary coffin or shell in which a corpse is laid to delay the natural decay by exposure to an artificially cooled atmosphere. In Fig. 1478, the metallic case has an interior wire basket to receive the corpse. Between the basket and case are pipes which contain a freezing mixture. The cover has hollow pockets for the circulation of air, which passes into the pans to which the tubes are attached. The inner cover is cooled with ice, and the outer one incloses the interior arrangements.

Fig. 1478.



Corpse-Preserver.

Cor'ri-dor. 1. (*Fortification.*) The covered way forming a walk around the whole of the work.

2. (*Architecture.*) A gallery or open communication to the different apartments of a house.

Cor'ru-gat'ed I'ron. Sheet-metal pressed into wrinkles or folds, so as to give it greater stiffness. It is used in many ways; as sheathing, house-covering, roofing, etc.

"As admirably shown by Buckland, the partitions which separate into chambers all the whorls of the ammonite except the outermost one were exquisitely adapted to strengthen, by the tortuous windings of their outer edges, a shell which had to combine great lightness with great powers of resistance. Itself a continuous arch throughout, it was supported by a series of continuous arches inside, somewhat resembling in form the groined ribs of the Gothic roof, but which, unlike the ponderous stone-work of the medieval architects, were as light as they were strong. And to this combination of arches there was added, in the ribs and grooves of the shell, yet another element of strength, — that which has of late been introduced into iron roofs, which, by means of their corrugations, — ribs and grooves like those of the ammonite, — are made to span over wide spaces without the support of beams or rafters. Still more recently, the same principle has been introduced into metallic boats, which, when corrugated, like the old ammonites, are found to be sufficiently strong to resist almost any degree of pressure without the wonted addition of an interior framework." — HUGH MILLER.

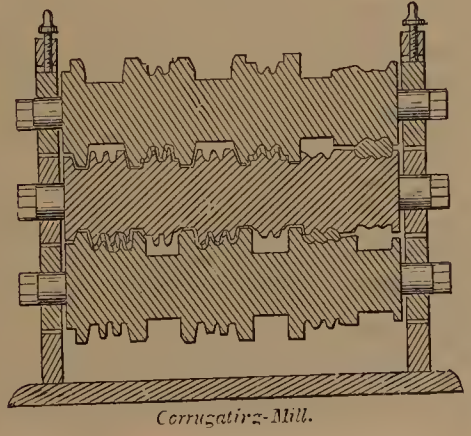
Fig. 1479.

Ammonites humpriesianus (*Oolite*).

Cor'ru-gat'ing-ma-chine'. A machine for corrugating sheet-metal.

In one form it is a rolling-mill in which a series of parallel grooves, alternating with parallel elevations, is cut in the circumference of the central roll, and counterpart grooves and elevations are formed in the upper and lower roll, so that the iron is passed consecutively between the rolls in opposite directions; in another form the rolls are grooved longitudinally. In another form the corrugation is by simple pressure between dies.

Fig. 1480.



Corrugating-Mill.

Co-run'dum. A hard mineral consisting of crystalline alumina. The sapphire and ruby are allied substances of different colors. Emery is a dark-colored, granular variety. See EMERY.

Corundum is used in powder of varying fineness; is made up into wheels and laps with gums, resins, glue, etc.; is used by dentists in the form of cones, cups, files (round, taper, and oval), slabs, wheels, laps, bobs, points, tape.

It is made into various grades by pounding and sifting. Is molded in forms and presses.

Cor-vette'. (*Nautical.*) A ship-rigged man-of-war with a flush deck, and carrying from eighteen to twenty-six guns, in one tier. It ranks next below a *frigate*.

Cor'set-mak'ing Ma-chine'. A loom for weaving fabrics having an undulating contour of varying dimensions. It is arranged to make the tubular spaces for the introduction of the whalebones. In the machine exhibited at the French Exposition in 1867, the principle of a constant length of travel for the shuttle was adopted for the sake of simplicity; but as it is necessary, in weaving the gores, that the weft-thread should pass through only a part of the breadth of the warp, the Jacquard has been employed for the purpose of taking up the portion of the warp required to be woven in that part. As the shuttle always passes over the full breadth of the warp, of which only one portion, say one third, is to be used, it unwinds the full length of weft thread from the bobbin, but only one third of it is tied in the warp. In repassing the shuttle one third more is tied, thus leaving one third of the unemployed weft-thread in the form of a loop upon the article manufactured. To remove this superfluous thread, the thread-catcher, which is a lever with an elastic finger, passes from behind, through the lay on each side of the reed, and pulls the thread out. The shuttle is conveyed by a carrier to the center of the warp, where it is taken by the other carrier and passed through the remainder of its course.

The most difficult part of the work is performed by the *regulator* or *take-up motion*, the action of which is to take up the woven cloth in such a manner as to leave a straight line in front of the reed. As the cloth is woven first only on one side; then for the whalebone pockets, where the cloth is double, evenly over the full breadth; thirdly, on the other side only; and, finally, for the full breadth at the back and front of the stay, — the motion of the regulator must change accordingly. To effect this, the cloth passes between two sets of rollers, the upper of which are simple pressure-rollers, to be regulated by springs and set screws. The lower rollers are fluted and worked by a system of levers independent of each other. The levers are worked conjointly by the Jacquard and lay, so that the lay gives only a movement to those levers which have been previously acted upon by the Jacquard.

An elastic-warp tension is obtained by a peculiarly constructed lever combined with an elastic brake, so as to render the whole machine fit for flat, convex, plain, or richly ornamented work, according to the

cards placed upon the Jacquard, and the material put in warp and shuttle.

Cos'aques. French fancy paper for wrapping sweetmeats.

Cos'mo-labe. An astronomical instrument resembling the astrolabe, and formerly used for measuring angles.

Cos'mo-ra'ma. A pictorial exhibition in which the views are laid horizontally upon a semicircular table, and reflected by diagonal mirrors to the lenses at which the eye of the spectator is successively applied. The pictures are illuminated by hidden lamps.

Cos'mo-sphere'. An apparatus for exhibiting the relation of the earth to the fixed stars. A terrestrial globe is placed in the center of a large, hollow glass sphere on which are depicted the stars and constellations.

Cos'sas. (*Fabric.*) A kind of plain India muslin.

Cos'tean-ing. (*Mining.*) A Cornish term for a method of prospecting for metallic lodes. Trenches or pits are dug in the superficial strata, and united by a drift which crosses the direction of the vein, if any exist; the veins in the vicinity affording a guide for direction. *Costeening.*

Cot. 1. A sort of refuse wool.

2. A sheath or sleeve; as a clothing for a drawing-roller of a spinning-frame; a cover for a sore finger.

3. A rude boat, as a dug-out or canoe.

4. A bedstead.

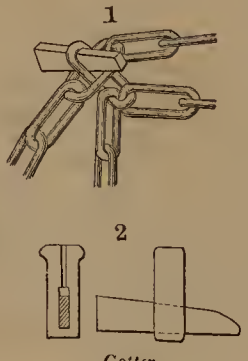
Co-til'lion. (*Fabric.*) A woolen material in black and white for ladies' skirts.

Cot'tage-chair. A form of chair adapted for comfort rather than show, and capable of being carried on to the lawn, on picnics, etc. A *folding* chair.

Fig. 1481.

Cottage-Chair.

Fig. 1482.



Cotter.

Cot'ter. A key. A wedge-shaped piece driven between the gibs in attaching a strap-head to a connecting-rod and tightening the brasses of a bearing. See KEY.

1. A key inserted into a link which has been passed through another link of a chain. A broken chain is thus temporarily mended. This mode is adopted in fastening a log on the sled, and generally in securing an object by a chain when the whole length of the latter is not required. The hook at the end of the chain usually forms the *cotter*, and it is much better than making a running noose of the chain in the link, as the latter is difficult to unfasten, while the cotter can be slipped or driven out, leaving all free. A *toggle*.

2. A wedge which is driven alongside the end of the tongue in the mortise of the sled-roller, tightening the latter against the *gib*. See GIB.

The cotter used for temporarily holding an iron plate to the rib of a vessel while being riveted is shown at 2, Fig. 1482. The cotter has a slight spring, and the taper pin has a wedging action upon the plate.

Cot'ter-drill. A drill for boring slots; it or the work having a lateral motion after its depth is attained.

Cot'ter-file. A narrow file with straight sides, used in filing grooves for cotters, keys, or wedges.

Cot'ter-plates. (*Founding.*) The flanges or lips of a mold-box.

Cot'ton. A plant, or the fibrous product thereof, having a scientific Latin name (*gossypium*), but an Arabic common name (*goton*), which pleasantly reminds us of the great people from whom we derived it.

Herodotus (Book III. c. 106) refers to the cotton of India: "The wild trees of that country bear fleeces as their fruit, surpassing those of the sheep in beauty and excellence; and the Indians use cloth made from this tree-wool." In another place he states that the Indian contingent of the army of Xerxes wore cotton drawers (Book VII., German *Baumwolle*, tree-wool, c. 65).

Theophrastus, the disciple of Aristotle, derived farther information from the expedition of Alexander, and says: —

"The trees from which the Indians make clothes have a leaf like that of the black mulberry, but the whole plant resembles the dog-rose. They set them in the plains arranged in rows, so as to resemble vines at a distance. They bear no fruit, but the capsule containing the wool is, when closed, about the size of a quince, and when ripe it expands so as to emit the wool, which is woven into cloths, either cheap or of great value."

Aristobulus, one of Alexander's generals, mentions the cotton-plant as the "wool-bearing tree," and stated that its capsules contained seeds, which were taken out, and that what remained was combed like wool. Nearchus, Alexander's famous navigator, also refers to it, and says that the shirts, mantles, and turbans of the people of India were made of it. Strabo, on the authority of Nearchus, refers to the fabrics of cotton as being flowered and beautifully dyed.

An awning of cotton was spread over the theater by Lentulus Spinther, July 6, 63 B. C. Linen had been formerly used.

Pliny mentions cotton in four places in his Natural History; two refer to the account of Theophrastus, one to the *carbasa* (cotton) of Spain, one to the cotton of Egypt: —

"In Upper Egypt, towards Arabia, there grows a shrub, which some call *gossypium*, and others *xylon*, from which the stuffs are made that we call *xylina*. It is small, and bears a fruit resembling the filbert, within which is a downy wool which is spun into thread. There is nothing to be preferred to these stuffs for softness and whiteness; beautiful garments are made from them for the priests of Egypt."

The old hatred of the Egyptian priests for wool and preference for flax would not militate against the cotton when they found it to be vegetable growth. In the earlier periods of the Nile people, nothing but linen was used by priests or for embalming.

Arrian the historian (d. A. D. 140) cites the importations from the East to Europe of cotton goods, plain and ornamented. The muslins of Bengal were then called *Gangitiki*, to indicate that they came from the Ganges. The Indian names yet survive in the words *muslin*, named from Moussol, and *calico* from Calicut.

Julius Pollux, in the Onomasticon (A. D. 170), refers to the cotton of India, which he terms *byssus*, and compares with flax: —

"The tree produces a fruit most nearly resembling

a walnut, but three-cleft. After the outer covering, which is like a walnut, is divided and dry, the substance resembling wool is extracted, and is used in the manufacture of cloth for woof, the warp being linen."

Cotton paper used by the gold-beater is mentioned by Theophilus Presbyter about A. D. 800.

On the discovery of America by Columbus, cotton formed the principal article of clothing among the Mexicans. They interwove it with fine-spun hair of rabbits, or with feathers for state robes. The cuirasses of thick cotton fabric were proof against the Indian missiles, and were adopted by the Spaniards. The nobles wore instead, cuirasses of thin plates of gold or silver with surcoats of feather-work.

Among the presents stolen or purchased by the brutal Cortez and sent to Charles V. were "cotton mantles, some all white, others mixed with white and black, or red, green, yellow, and blue; waistcoats, counterpanes, tapestries, and carpets of cotton; and the colors of the cottons were extremely fine." — CLAVIGERO'S *Conquest of Mexico.*

The Mexicans had indigo and cochineal.

Columbus found the cotton-plant wild in Hispaniola, in other West India islands, and on the continent of South America, where the natives used it for dresses and fishing-nets.

Magellan, in 1519, found the Brazilian natives reposing on beds of cotton down.

Cotton goods were familiar to the Arabs in the time of Mohammed, A. D. 627, and the culture was carried by his followers through the Mediterranean coast of Africa into Spain, whence the fabric reached the less civilized parts of Europe. Abderrahman III. commenced the manufacture of cotton in Spain, and in the fourteenth century it was introduced into Italy.

When the best part of the inhabitants of Spain were expelled, when the University of Cordova became a thing forgotten on the peninsula, when the memory of Alhazen was lost, and the era of the Pedros and Philips commenced, then the cotton-plant, too, faded away, and all the industries growing out of this beautiful staple languished. The culture and manufacture revived again in Spain at Valencia and Barcelona respectively.

Fabrics and yarns were largely imported from the East into Europe for several centuries; but the manufacture of the *cotton-wool*, as it was long called, gradually crept into the various countries of Europe.

The earliest notice in England is by Roberts, 1641, who describes the excellent goods, "*fustians, vermillions, dimities*, and other stuffs," made by the inhabitants of Manchester, of "*cotton-wool* brought from Smyrna and Cyprus." First made by machinery by Louis Paul in 1736–40. See COTTON-MACHINERY.

In the seventeenth century, cotton fabrics were so largely imported into England from India as to interfere with the woolen, linen, and silk interests, and the importation of cotton goods was forbidden in 1700.

An act of parliament in 1721 imposed a fine of £5 on the wearer of cotton and £20 on the vendor. It was thought to be the ruin of England, and every depression in trade was charged on the cotton, which was superseding wool. Thirty years afterward the annual value of manufactured cottons was £200,000. In 1860 it was £52,000,000. In 1823, Great Britain employed 10,000 steam-looms; the number in 1865 was 400,000, driven by steam-power estimated equal to 294,000 horses, and directly employing 1,000,000 persons.

The Parliamentary Report of 1851 states the number of pounds of cotton worked into yarn per day (nearly) . . . . . 2,000,000 pounds.

Spindles in operation . .	20,000,000
Power-looms	250,000
Factories	2,000
Hands employed inside the walls	350,000
Horse-power (steam and water) .	80,000
Production of cotton goods in 1850 per day . . .	4,000,000 yards.
Production of unwoven cotton yarn per day . . .	500,000 pounds.

Cotton-seed was brought into England from the Levant; taken thence to the Bahamas, and thence to Georgia in 1786. The first cotton-mill in America was at Beverly, Mass., in 1788.

In the following list are associated the terms used in the description, manufacture, and products of fibrous material, excepting those involving pulping, which will be found under the indical head of PAPER (which see). The following list includes cotton, flax, wool, hemp, silk, etc., appliances. See —

Ageing.
Balling-machine.
Bat.
Batting.
Batting-machine.
Beating-engine.
Bier.
Billy.
Bink.
Bleaching.
Block-printing.
Blower and spreader.
Blowing-machine.
Bobbin.
Bobbinet-machine.
Bobbin-winder.
Bobbin and fly frame.
Boon.
Bott-hammer.
Braiding-machine.
Braid-sizing and polishing machine.
Brake. Flax and hemp
Branning.
Breaker.
Breaking-frame.
Breaking-machine.
Bronze.
Brushing-machine.
Bucking.
Bucking-keir.
Buffalo.
Bunch.
Bundle.
Bundling-press.
Burling-iron.
Burling-machine.
Burr.
Burring-machine.
Cable-laid.
Calendering-machine.
Calico-printing.
Can-frame.
Can-roving machine.
Canvas-frame.
Card.
Card-clothing.
Card-grinding.
Carding-engine.
Carding-machine.
Card-machine.
Card-setting machine.
Carriage.
Carrier.
Cask.
Caudroy.
Chamber.
Chemicking.
Chenille-machine.
China-blue style.
Circular bolt.
Clasp.
Cleaning-machine.
Clearer.
Clearing.
Cloth.
Cloth-creaser.
Cloth-crimping machine.
Cloth-cutting machine.
Cloth-dressing machine.
Cloth-drying machine.
Cloth-embossing machine.
Cloth-finishing machine.
Cloth-folding machine.
Cloth-measuring machine.
Cloth-napping machine.
Cloth-press.
Cloth-shearing machine.
Cloth-smoothing machine.
Cloth-sponger.
Cloth-stretcher.
Cloth-teaseler.
Cloth-tenter-bar.
Coiling or laying slivers.
Color-doctor.
Column.
Clouded-yarn machine.
Comb.
Comb-broach.
Combing-machine.
Condenser.
Cone-pulley.
Cop.
Copping-plate.
Copping-rail.
Cop-tube.
Cop-winder.
Cord.

Cord-covering machine.
Cord-dryer.
Cot.
Cot-roller.
Cotton.
Cotton-cleaner.
Cotton-elevator.
Cotton-gin.
Cottonizing-fiber.
Cotton-paper.
Cotton-picker.
Cotton-press.
Cotton-thread.
Counterfaller.
Craping-machine.
Creel.
Creeping-sheet.
Crisper.
Crofting.
Cross-shearing machine.
Cut.
Cutting-engine.
Damping-machine.
Dash-wheel.
Decoloring-style.
Dent.
Devil.
Discharger.
Discharge-style.
Distaff.
Doffer.
Doffing-cylinder.
Doffing-knife.
Doubler.
Doubling.
Doubling and twisting machine.
Drawing.
Drawing-frame.
Drawing-head.
Dresser. Copper
Dressing-machine.
Drum.
Drying-machine.
Dumb-singles.
Dunging.
Dust-room.
Dyeing.
Embroidering-machine.
Enleavage-style.
Equational-box.
Fabric (see list).
Faller.
Faller-wire.
Felt.
Felting-machine.
Fiber-cleaning.
Fiber. Separating animal and vegetable
Filling-engine.
Fine-drawing.
Finishing-card.
Fishing-net machine.
Flat.
Flax.
Flax and hemp brake.
Flax-cleaning machine.
Flax-cotton.
Flax-cutting machine.
Flax-dresser.
Fleece.
Flock.
Flock-duster.
Flocking-machine.
Floss silk.
Fluting-machine.
Flyer.
Fondu.
Frame.
Frizzing-machine.
Fulling.
Fulling hat-bodies.
Fulling-mill.
Fulling-stock.
Gasing.
Gig.
Gigging-machine.
Gill.
Gill-frame.
Gimp-machine.
Gin. Cotton
Glossing.
Grounding-in.
Habeck.
Hackle.
Hackling-machine.
Hair-rope picker.
Hand-spinning machine.
Hank.
Harle.
Harp.
Hatchel.
Hawser.
Hawser-laid.
Heck-box.
Heckle.
Heckling-machine.
Heddle.
Hemp.
Hemp-brake.
Hook-frame.
Hot-flue.
Iron-man.
Jack-frame.
Jack in a box.
Jenny.
Kemp.
Knitting-burr.
Knitting-machine.
Knotting.
Lace-machine.
Lag.
Lantern.
Lap.
Lap-frame.
Lapping-machine.
Lay.
Laying-machine.
Lea.
Leaver-machine.
Lewis.
Licker-in.
Linen-prover.
Lint-doctor.
Loom (see WEAVING).
Madder-style.
Mangle.
Marabout.
Mordant.
Mosaic-wool.
Mule.
Napping-cloth.
Netting-machine.
Noils.
Oiling.
Opening-machine.
Organzine.
Pad.
Packaging-machine.
Padding.
Parroting.
Picker. Cotton
Picking. Cloth
Pigment.
Pile.
Pirn.
Planking-machine.
Plaquage-style.
Plucker.
Polishing. Yarn and thread
Pouncing-machine.
Printing.
Presser-bar.
Presser-flyer.
Puffer-pipe.
Quill.
Quilting-frame.
Rap.
Raw-silk.
Reed.
Reel.
Reeling-machine.
Reëntering.
Reserve-style.
Resist.
Retting.
Ribbon.
Ring and traveler.
Ring-spinner.
Rinsing-machine.
Ripple.
Roll.
Roll-boiling.
Roller-bowl.
Rongeant-style.
Rope.
Rope-making machine.
Rope-winch.
Roving.
Roving-frame.
Scavenger-roll.
Scouring.
Scribbling-machine.
Scrimping-bar.
Scutcher.
Scutching-machine.
Shake-willy.
Shearing.
Sheeting-machine.
Shives.
Shove.
Shroud. Hawser-laid
Shuttle.
Silk.
Silk-cleaning knife.
Silk-doubling machine.
Silk-filature.
Silk-reel.
Silk-sizing machine.
Silk-sorting machine.
Silk-stretching machine.
Silk-twister.
Silk-winder.
Singeing-machine.
Singer.
Singles.
Sinker.
Sizing-machine.
Skein.
Skewer.
Skip.
Slab.
Sliver.
Sliver-box.
Slub.
Slubbing.
Slubbing-machine.
Souring.
Speeder.
Spindle.
Spinel.
Spinning.
Spinning-jack.
Spinning-jenny.
Spinning-machine.
Spinning-wheel.
Spirit-colors.
Spool.
Spooling-machine.
Spool-labeling machine.
Spoon.
Spreader.
Spreading-frame.
Spun-yarn.
Squirrel.
Steam-chest.
Steeping.
Stocking-frame.
Stocking-machine.
Stop-finger.
Strand.
Stretcher-mule.
Stretching-frame.
Strick.
Suint.
Sulphuring.
Swift.
Swimming-tub.
Swingle.
Swing-stock.
Teaseling-machine.
Tenter.
Tenter-bar.
Tewing-beetle.
Thread.
Thread-finisher.
Thread-frame.
Thread-machine.
Thread-polisher.
Thread-winder.
Throstle.
Throwing.
Thrown-silk.
Thrum.
Top.
Top-flat.
Tow.
Tram.
Twilly.
Twine-machine.
Twine-reeler.
Twist.
Urchin.
Wadding.
Wadding-sizer.
Warp.
Warp-dresser.
Warp-frame.
Warping-hook.
Warping-jack.
Warping-mill.
Warp-machine.
Waste-picking machine.
Water-frame.
Water-laid.

Water-twist.
Waxing.
Whirl.
Whirlers.
Willowing.
Willy.
Wincing-machine.
Winding-machine.
Wolf.
Woof.
Wool.
Wool-burring machine.
Wool-cleaner.
Wool-combing.
Wool-dryer.
Wool-machinery.
Wool-oiler.
Wool-picker.
Wool-press.
Wool-sorting.
Wool-table.
Wool-washer.
Worker.
Worsted.
Yarn.
Yarn-cleaner.
Yarn-dryer.
Yarn-printing machine.
Yarn-reel.
Yarn-winder.

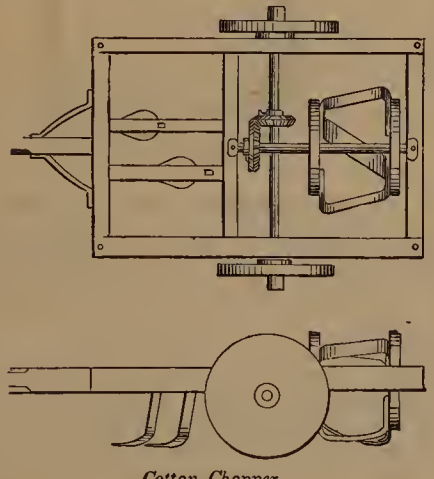
Cot'ton-ade. (*Fabric.*) Cotton check.

Cot'ton-bale Tie. See BALE-TIE.

Cot'ton-brush Chop'per. A machine with revolving knives to cut up the old dried cotton-stalks, to prepare the land for plowing for another crop.

Cot'ton-chop'per. An implement which is drawn over a drilled row of cotton-plants, and chops

Fig. 1483.



Cotton-Chopper.

gaps in the row so as to leave the plants in bunches or hills. The machine is supported on two wheels, and has a plow to run on each side of the row. Motion is communicated from the rotary axle by bevel-wheels to a revolving head having oblique cutters, which chop gaps in the row of plants as the machine progresses.

Cot'ton-clean'er. A machine for separating the dust and dirt from cotton. This is performed by a scutching and blowing action, the tussocks of cotton being torn asunder and opened, allowing the dirt to fall out. The heavier portions fall through gratings, and the lighter are carried off through air-ducts by means of exhaust-fans.

Machines for this purpose are of very variable construction, less uniformity existing in this department than in any other of the series of operations in cotton. The preliminary processes of the cotton-mill are *unpacking*, *sorting*, *picking*, *cleaning*, *willowing*, *batting*, and *lapping*.

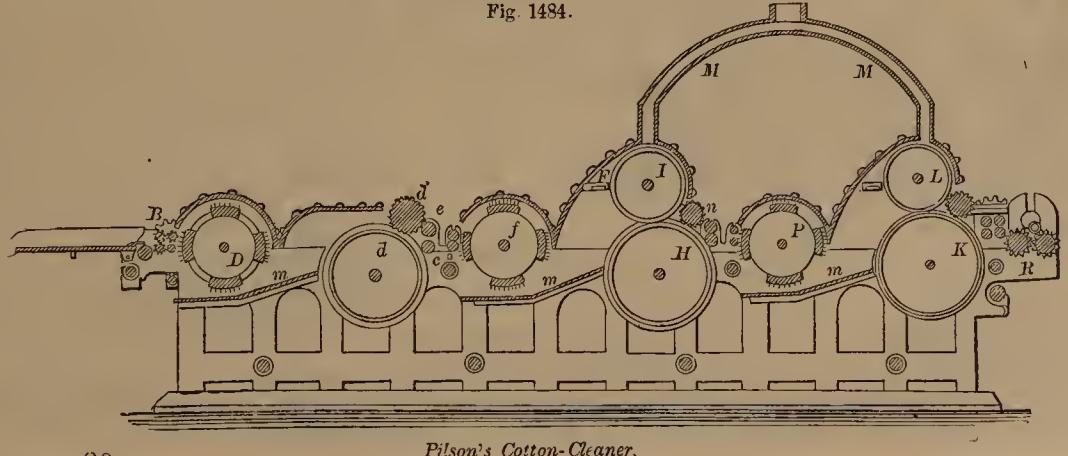
The *cotton-cleaner* (Fig. 1484) has a long series of consecutive operations. The cotton from the feeding-table is passed between a pair of fluted rollers *B*, then between smooth rollers, which present it to the action of the toothed scutcher *D*, which revolves rapidly and wafts the loosened filaments towards a wire cylinder *d*, over which it travels, being compressed by a fluted roller *d'* in its passage, and thence between a pair of smooth rollers *e*, which condense it into a *bat* ready for a repetition of the operation. Passing between another pair of rollers, the web of cotton is presented to the second scutcher *f*, which has finer and more numerous teeth, and drives the fibers forward to the wire cylinders *H I*, a knife *C* keeping clear the lower roller of the last feed-pair. The dirt falls between the bars of the gratings *m*, over which the cotton passes successively as it comes from the consecutive scutchers, and the lighter dust passes through the meshes of the wire cylinders *H I K L*, an exhaust-draft of air operating from the periphery of the cylinders inward, and the dust passing off by ducts to the case in which the exhaust-fan rotates, and thence by a suitable chute to the open air or cellar.

A deflector *F* prevents the passage of the cotton upward to the chute, forming a wiper for the cylinder *I*. The bat of cotton, by passing between *two* wire cylinders, is subjected, on its upper and lower surfaces respectively, to a drawing action, which removes the dust, and is believed to accomplish it more perfectly than when the operation is confined to one side of the bat, a single cylinder being employed.

The bat from the cylinders *H I* is subjected to the pressure of a toothed roller *n*, which acts as a doffer to the upper cylinder, and thence passes between a pair of condensing rollers, which compact it previous to a repetition of the operation.

A third set of feed-rollers next present the bat to scutcher *P*, which delivers the filaments, thus opened for the third time, to the wire cylinders *K L*, whence it issues in a partially compacted wad, and is passed, by the fluted doffer and two pairs of

Fig. 1484.



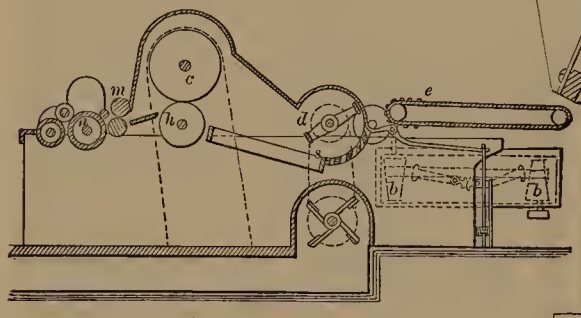
Pilson's Cotton-Cleaner.

pressure-rollers, to the lap-roller *R*, on which it is wound, ready for the operation of carding.

Another machine has a device for regulating the speed of the feed-apron by the weight consequent upon the thickness of the layer of cotton presented, the object being to present equal quantities in equal times to the *licker-in*. The concave *s* is supported on a center, and its oscillations affect the position of the band on the cone-pulleys *b* below, so as to vary the speed of the traveling feed-apron *e*.

As the cotton passes beyond the roller, it is struck by the arms of the scutcher *d*, and delivered on to the grid *s*, whose bars are longitudinal and offer no obstacle to the motion of the fibers, while the spaces allow the dirt to fall. The cotton then passes between the surfaces of the

Fig. 1485.



Lord's Cotton-Cleaner.

wire cylinders *c h*, which have an internal exhaust to remove the dust. From thence the bat passes to the pair of condensing-rollers *m*, and then to the lap-roller *n*, on which it is wound.

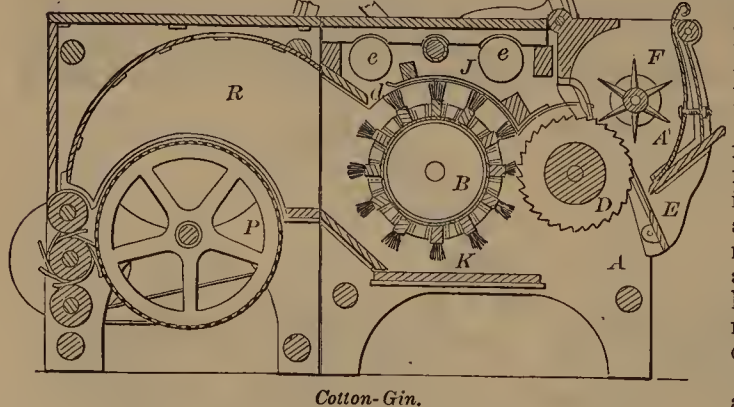
Cot'ton-ee. (*Fabric.*) A Turkish fabric of cotton and silk satinet.

Cot'ton-el'e-va'tor. An arrangement in a cotton-mill of a tube with air-blast or spiked straps for carrying cotton to the upper stories.

Cot'ton-gin. A device, originally invented by Whitney, 1794, in which lint is picked from the seed by means of saw-teeth projecting through slits in the side of the chamber in which the seed-cotton is placed.

In the example, the cotton occupies chamber *F*, where the picker-roll *A'* rotates. *E* is a grid form-

Fig. 1486.

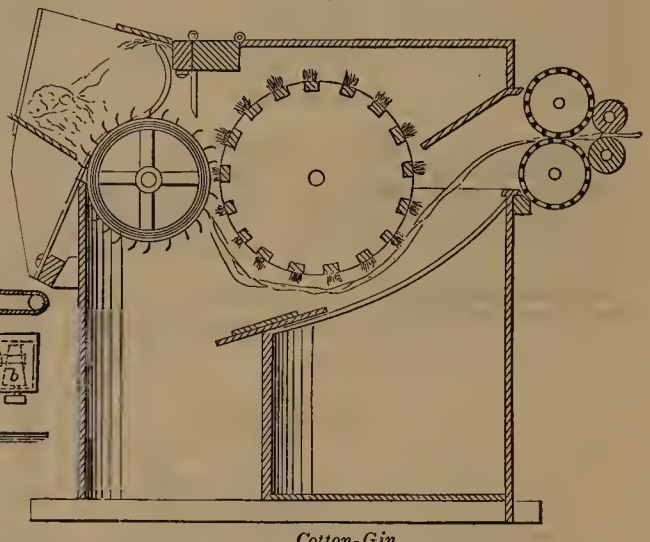


Cotton-Gin.

ing one side of the chamber, and through its intervals pass the teeth of the saws *D*, which are arranged in a row upon a mandrel driven by the motor. The fibers of lint being drawn by the teeth between the bars of the grid *E* are brushed from the saw by the rotating brush-cylinder B, and the heavier specks fall upon the mote-board *K*, while the lint and dust pass to the chamber *R*, and fall upon the wire-gauze surface of the cylinder *P*, the dust passing through and being conducted out of the machine, while the lint is arrested and passes to the doffing and compacting cylinders, from which it issues as a bat.

In Fig. 1487, instead of saws are needle-pointed teeth. The teeth are set obliquely to the radial

Fig. 1487.



Cotton-Gin.

lines of the ginning-cylinder, which is composed of segments of rings which admit of separate removal. The cotton is doffed by a brush-cylinder, and received by and condensed between two smooth cylinders, which make it into a bat and allow the dust to pass off.

Cot'ton-hook. A claw with a handle, by which cotton-bales are moved in loading and shipping.

Cot'ton-iz'ing Fi'ber. A process of disintegrating fiber, adopted with flax, hemp, jute, cane, etc., so as to reduce them to a short staple resembling cotton, which can be worked on cotton-machinery.

P. Claussen's patent, 1851, No. 8134, describes a process for reducing vegetable fiber to a condition for being spun or felted, by saturating it with a solution of carbonate of soda and potash, and then to a solution of sulphuric acid, so as to generate carbonic-acid gas within the cellular structure, and thus tear it to pieces and dissolve the mucilaginous matters. See Flax-cotton.

Lyman's patent, August 3, 1858, is for what is called the "fiber-gun." Wool, flax, hemp, jute, cane, etc., are confined in a cylinder, and charged with steam at a very high pressure. By a sudden movement, the material is released and explodes into a chamber, the violent expansion rupturing the cells and reducing the material to a disintegrated condition.

There are many modifications of the alkali and acid treatment, and of the resulting washing, bleaching, and drying processes, by which mucilage, color, and silex are removed.

Cot'ton-ma-chin'er-y. The progress of a bale of cotton to the condition of thread or yarn may be briefly stated as follows; —

1. *Sorted* and mixed, to give uniform quality to a given lot. The cotton is piled in layers in a *bink*, and, in taking it from the side of the heap, the cotton of the several strata is an average of the whole.

2. *Scutched* or *willowed*, to tear the matted masses apart and open out the fibers.

3. *Cleaned* and *batted* by a combined tearing and blowing action.

4. The bat is farther treated in a similar manner, the filaments being more divided, received on a wire-gauze drum, pressed into a thin sheet, and delivered as a *lap* upon a roller.

5. *Carded*, to straighten the fibers, which are delivered in *fleeces* or *slivers* by the *doffer;* that is, in broad or narrow films or transparent sheets of fiber; or the *fleece* is reduced to a *sliver* by being passed through a funnel and consolidated by rollers.

6. *Doubled* and *drawn*, to complete the parallelism and elongate the ribbon. By the repetition of this process, the possible inequalities of separate ribbons are lost by throwing them together and re-drawing again and again, and depositing in cans.

7. *Roving*, to attenuate and slightly twist the spongy cord and wind it on bobbins.

8. *Fine-roving* and *stretching* by the *bobbin-and-fly* frame or the *stretcher-mule*, delivering on bobbins.

9. *Spinning* in the *throstle*, which continuously *draws*, *twists*, and winds the yarn (for warp); or in the *mule*, which *draws* out and *twists* lengths of about 56 inches, and then winds upon the spindles (for weft).

10. *Winding*, *doubling*, and *singeing* the yarns, to fit them for the weaver.

11. Packing.

12. Dressing.

13. Warping.

14. Weaving.

N. B. There are many varieties and differences in machines and processes, and some even in the order of details. Much difference also exists in the machines for finer or coarser work, so that, while the above list is substantially accurate, it will not be found to agree with the order of all factories, and perhaps not in every respect with any one.

The inventions involved in the treatment of cotton by machinery are about as follows: —

Fly-shuttle, John Kay, of Bury, 1738.

Carding-machine, Lewis Paul, 1738.

Drop-box, Robert Kay, 1760.

Spinning by rollers, Lewis Paul or John Wyatt, 1738.

Spinning-jenny, Hargreaves, 1767.

Water-frame, Arkwright, 1769.

Power-loom, Rev. D. E. Cartwright, 1785.

Cotton-gin, Eli Whitney, 1794.

Dressing-machine, Johnson and Radcliffe, 1802–1804.

Power-loom, Horrocks, 1803–1813.

Mule, Samuel Crompton, 1774–1779.

Self-acting mule, Roberts, 1825.

See COTTON, FLAX, WOOL, HEMP, SILK, ETC., APPLIANCES, p. 631.

A cotton-factory cited by Ure has machines in the following proportions: —

1 *willow*, 1 *blowing-machine*, 1 *lap-machine*, capable together of cleaning and lapping 9,000 pounds of cotton per week.

21 *cards*, *breakers*, and *finishers;* joint capacity 5,000 pounds per week of 69 hours.

3 *drawing-frames* of 3 heads each.

2 coarse *bobbin-and-fly frames*.

7 fine *fly-frames*.

12 self-acting *mules;* 404 spindles each.

10 *throstle-frames;* 236 spindles each.

7 *dressing-machines*.

236 *power-looms*.

2 *warping-mills*.

300 *warp-winding* spindles.

The rovings have four hanks in the pound, and are spun into yarn No. 38 on the throstles as well as by the mules.

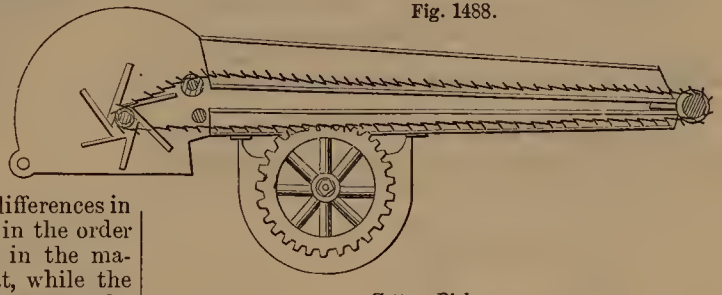
Cot'ton Pa'per. We are indebted for cotton paper to the Arabians, and it is surmised that they learned it of nations still east of them. The use of cotton for this purpose was probably derived from "far Cathay" (China), whence we received gunpowder, porcelain, the mariner's compass, and the art of glazing earthenware.

The first use of cotton paper in Europe was among the Saracens in Spain, and cannot be traced back beyond the tenth century. In Europe, it preceded the use of flax fiber for that purpose. The paper of Xativa, a city of Valencia, was famous in the twelfth century. See PAPER.

Cot'ton-pick'er. 1. A machine for scutching cotton to tear apart the matted masses and clean it. See COTTON-CLEANER.

2. A machine for picking cotton from the bolls of the plant. One form consists of a traveling toothed belt, which catches the cotton fiber and drags it into a receptacle. This form is shown in Fig. 1488, which has a toothed wheel working into

Fig. 1488.



Cotton-Picker.

the links of an endless chain having reflex spines, which strip the cotton from the bolls, and carry it to the other end of the machine, where it is thrown off into a receptacle by a revolving stripper.

Other machines have rotary brushes, and still others operate by blowers, flexible air-pipes, and nets which catch the fiber.

Cot'ton-press. One in which cotton is baled for transportation and storage.

There are various forms of cotton-presses, known as the screw, toggle, beater, revolving, hydraulic, portable, double-acting, windlass, rack-and-pinion, re-pressing, and rolling-pressure presses. See under those heads respectively.

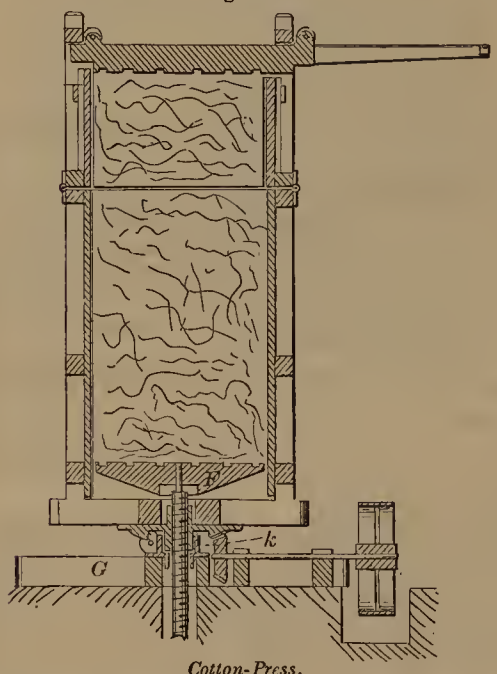
The old form of press was the screw, which ascended vertically from the follower and worked in a nut in the upper cross-beam. It was rotated by a sweep.

In the illustration is a modern form of the screw-press, which leaves the upper end of the box open for filling, the screw working from beneath.

The cotton is confined in a long rectangular chest that revolves on a vertical axis, engaging a screw that drives the follower.

The bevel-wheel *k* is driven by the shaft and band wheels, and engages another bevel-wheel, which is secured, teeth down, beneath the sill-framing of the box, which runs on rollers on the rim of the curb *G*. As the box rotates, the screw rotates in its nut, and elevates the follower *F*.

Fig. 1489.

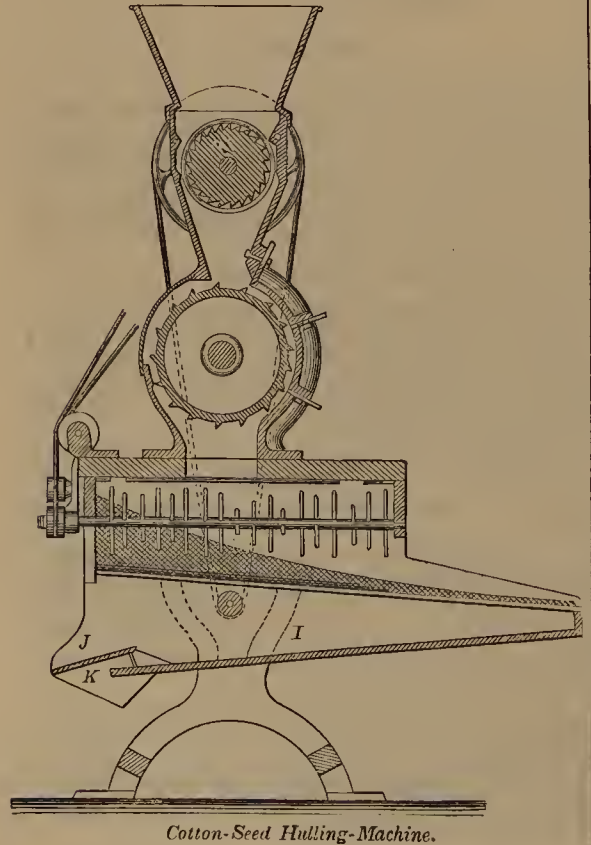


Cotton-Press.

Cot'ton-seed Clean'er. A machine for tearing the remaining fiber from the cotton-seed, or one which so far compacts the fiber upon the seed that the latter will roll upon itself without making a mat, and so become fitted to be sown by an ordinary machine.

Cot'ton-seed Hull'er. A machine by which the hull of the cotton-seed is rasped off and sifted from the farinaceous and oily matters, which are utilized for their oil and the refuse for manure. The kernels pass through the screen, while the coarser hulls and fibers are carried along and discharged from the lip of the screen. The hulled seed is then received into the box-screen *I*, which, being shaken by suitable mechanism, separates the still remaining lighter portions of the hulls that pass the wire screen, carrying these portions out over the apron *J*, while the cleaned and hulled seed passes out through the chute *K*.

Fig. 1490.



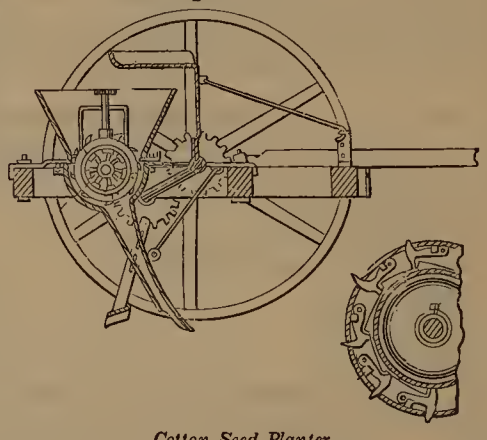
Cotton-Seed Hulling-Machine.

Cot'ton-seed Mill. One for grinding the seed of cotton, either for manure or for obtaining from the meal the oil, either by pressure or the more usual mode of treatment by bisulphide of carbon (Sim's process) or hydrocarbon.

Cot'ton-seed Plant'er. One in which the feed-motions are positive, as the seed adheres by the interlacing of its fibers, and requires to be torn apart and driven down the chute to the ground.

In Fig. 1491, the adjustable teeth are arranged within a case in a hopper, and are operated by gearing in connection with the driving-wheel, and regulated by cams secured to the case, whereby the cotton-seed is projected down the tube. Rotating arms work in the case, preventing choking therein.

Fig. 1491.



Cotton-Seed Planter.

Cot'ton Thread. Cotton thread for sewing is made by laying together two or more yarns of equal quality and twisting them. Previous to the doubling and twisting, the yarn is passed through a trough containing a thin solution of starch. The twist is given in an opposite direction to that applied by the spinning-machine, as in the case of organzine silk.

Cot'ton-top'per. A machine which passes along and prunes the row of growing cotton-plants, in order to curb its rampant luxuriance.

Cot'trel. A hook and trammel for suspending a cooking-vessel.

Couch. 1. (*Malting.*) The heap of steeped barley on the floor where the grains undergo germination, effecting the change into *malt*. The operation of *couching* takes about fourteen days, and the subsequent kiln-drying, which arrests germination, takes two days.

2. (*Paper-making.*) To take the flake of imperfectly compacted pulp from the mold or apron on which it has been formed.

With hand-laid paper this is the business of the *coucher*, who receives the mold from the *dipper* and *couches* the sheet upon a *felt*.

In paper-machinery the operation is performed by a roller called the *couching-roller*.

3. A reclining seat, bed, or sofa.

The Greeks adopted the couch from the Persians.

"After this had been said, Cymilens asked for some spiced and boiled water to drink; saying he must wash down all those salt arguments with sweet drink. [Salted fish had been the subject under discussion.] And Ulpian said to him with some indignation, and *slapping his pillow with his hand*, 'How long will it be before you leave off your barbarian tricks?'" — *Deipnosophists*, III. 94.

4. (In *painting*, etc.) The ground or base on which the color is applied; a varnish or sizing. The term is also used in leather-gilding, gold-wire drawing, and other mechanical arts.

Couch'ing-in'stru-ment. One employed in depressing the opaque lens in cataract previous to removal.

Cou-lisse'. 1. A grooved piece of timber.

2. A pair of battens, or a groove in which a sluice-gate moves up and down.

Cou-lomb's Bal'ance. The torsion-balance; a form of ELECTROMETER (which see).

Coun'ter. 1. (*Shipbuilding.*) That part of a ship's stern which overhangs the stern-post. The *counter*-timbers spring from the *wing-transom*, which extends across between the fashion-pieces, crossing in front of the *stern-post*, near its head. At the top of the *counter-timbers* is the *taffrail*.

2. A bench or long table on which merchandise is exhibited or money-affairs transacted.

3. The back part of a boot or shoe, around the heel of the wearer, and to which the boot-heel is attached.

4. An apparatus attached to a steam-engine, printing-press, or other machine, for the purpose of counting the revolutions or pulsations, as the case may be. A game-scorer.

5. (*Mining.*) A cross vein.

Coun'ter-bal'ance. A weight in a driver or fly-wheel to overcome a dead point, or balance the weight of some object whose gravity affects the opposite side of the wheel.

A suspended weight to counterpoise the weight of a drawbridge, crane-jib, bob, or working-beam.

Coun'ter-bat'ter-y. A battery at the crest of a glacis, to silence the fire of the besiegers, and cover the storming party.

Coun'ter-beam. (*Printing.*) A beam connected to the platen by two or more rods, through the medium of which the reciprocating motion is communicated to the platen.

Coun'ter-brace. (*Nautical.*) The brace of the foretopsail to leeward.

Coun'ter-check. A plane for working out the groove which unites the two sashes of a window in the middle.

Coun'ter-die. The upper die or stamp.

Coun'ter-drain. (*Hydraulic Engineering.*) A drain at the foot of a canal or dike embankment, to catch and carry off the water.

Coun'ter-ex-ten'sion Ap-pa-ra'tus. For retaining firmly the upper part of a limb while extension is practiced upon the lower, in cases of fracture of the femur or the neck of the trochanter major, to enable the bony parts to unite without a shortening of the limb. It consists of coaction-splints for the femur (if that be the seat of the accident); a counter-extending band attached to the bed-head; and a round perineal band which passes around the crotch; an extending band fastened by starch bandage to the lower leg; a wooden block on the foot-sole, connecting the band to an extension cord, which runs over a pulley on the bed-foot.

Fig. 1492.

Counter-Extension Apparatus.

Coun'ter-fal'ler. (*Cotton-manufacture.*) In the mule-spinner, a counterweighted wire, which is depressed when the *faller-wire* lowers the row of yarns to wind them on the cop. Its duty is to balance the threads after they are depressed by the *faller-wire*, and to straighten them when loose.

Coun'ter-fort. (*Masonry.*) A pier or buttress bonded as a revetment to the back of a retaining wall, to support and also tie the wall, such as the scarp of a fort, to the bank in the rear.

The buttress is sometimes on the face. When arches are turned between counterforts, it is called a counter-arched revetment.

Coun'ter-gage. (*Carpentry.*) An adjustable, double-pointed gage for transferring the measurement of a mortise to the end of a stick where a tenon is to be made, or *vice versa*.

Coun'ter-guard. (*Fortification.*) A rampart in advance of a *bastion* and having faces parallel thereto.

Coun'ter-mine. (*Fortification.*) A mine by the besieged, to meet an approach, destroy an offensive position, or intercept a mine of the attacking party.

Coun'ter-mure. (*Masonry.*) The facing of a wall.

Coun'ter-pane. A coverlet, sometimes woven in raised figures. A quilt; a spread.

Counterpane-weaving is with two shuttles, one holding a much coarser weft than the other. The coarser is thrown in at certain intervals, and the thread is picked up with an iron pin, rather hooked at the point, so as to form knobs disposed in a sort of pattern.

Coun'ter-poise. A balance-weight upon a wheel or beam, as on the driving-wheel of a locomotive, etc. A *counterbalance*.

Coun'ter-poise-bridge. A *bascule*-bridge; the platform is raised by machinery or otherwise, the operation being assisted by counter-weights. See BASCULE; LIFTING-BRIDGE.

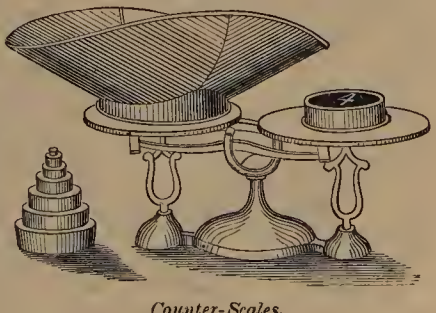
Coun'ter-proof. One taken by transfer from another proof just printed. The object is to furnish an engraver with a copy, non-reversed, of his plate.

Coun'ter-punch. (*Chasing.*) One which supports the metal beneath while the hammer is applied above, and may be the means of expanding a dented place by outward pressure while blows are given on the outer surface around the spot thus supported.

Coun'ter-rails. (*Shipbuilding.*) The ornamental molding across a square stern at the termination of the counter.

Coun'ter-scales. A convenient form of scales for counter or table use. It has many forms.

Fig. 1493.



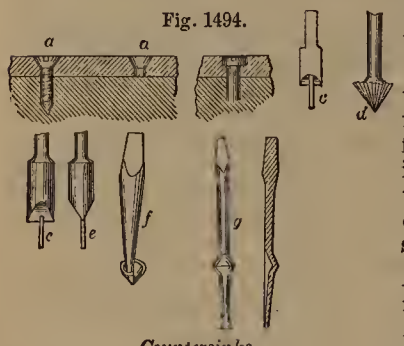
Counter-Scales.

Coun'-ter-scarp. (*Fortification.*) The wall on the outer side of the ditch, opposite to the *scarp*, which is on the fort side.

Coun'ter-shaft. An opposite and parallel shaft driven by band or gearing from the former one.

Coun'ter-sink. 1. An enlargement of a hole to receive the head of a screw or bolt.

Fig. 1494.



Countersinks.

The sides of the hole are merely chamfered (*a a*) when it is to receive the head of an ordinary wood screw.

When a flat-head screw or a bolt-head is to be let in flush with or below the surface, a flat bottom *b* is required.

2. A tool for making a countersink depression.

In watch-making, the countersinks *c c* are of the flat-bottom class; a central stem passes into the hole for the shank of the screw, and acts as guide for the cutting edge. *f* is a tapering countersink formed by a wing twisted into a spiral cutting edge.

Coun'ter-sink-bit. A boring-tool having a conical or cylindrical cutter, which makes a depression to suit the head of a screw. See *c d e f g*, Fig. 1494.

Coun'ter-sunk-head'ed Bolt. A bolt having a beveled head, which is let into a corresponding cavity in one of the pieces which it binds together. See BOLT.

Coun'ter-sunk Nail. A nail with a conical head like a wood-screw.

Coun'ter Swal'low-tail. (*Fortification.*) An outwork in the form of a single tenaille, with a wide gorge.

Coun'ter-tim'ber. (*Shipbuilding.*) One of the timbers in that part of a ship's stern which overhangs the stern-post.

Coun'ter-trench. (*Fortification.*) A trench made by the garrison to intercept that of the besiegers.

Coun'ter-val-la'tion. (*Fortification.*) Lines or earthworks around a fortress to repel sorties.

Coun'ter-vault. An inverted arch or vault.

Coun'ter-works. (*Fortification.*) Works undertaken for the purpose of destroying or rendering useless those of the enemy.

Count'ess. A size of slate. See SLATE.

Coun'try. 1. (*Mining.*) The rock or strata in which a metallic lode is found.

2. (*Fortification.*) The region outside of a fort down to which the glacis slopes.

Count-wheel. (*Horology.*) A wheel with peripheral notches, whose intervals are spaces whose proportions are 1, 2, 3, up to 12. The wheel governs the striking so far as to regulate the number of blows. The knife-edge detent being lifted out of a notch, the hammer vibrates so long as the edge rests on the portion of the wheel between the notches. These spaces are graduated in length, so as to allow the hammer to make 1, 2, 3, etc., vibrations up to 12, when it has completed a revolution and begins again. Seventy-eight blows are struck in a complete revolution. It is superseded in some clocks by the *rack* and *snail*, invented by Tompion.

Cou-pe'. 1. A four-wheeled close carriage with a single inside seat and a perch for the driver.

2. The front apartment of a French diligence or an English railway-car.

Coup'er. A lever on the upper part of the loom, to raise the harness.

Coup'le. (*Electricity.*) A voltaic couple is a pair of plates forming a battery, or a part of one.

Coup'led Col'umns. Columns arranged in pairs, where the nature of the openings, doors, windows, or niches precludes the usual intercolumnar distance.

Coup'ler. 1. (*Music.*) A connection between the corresponding keys of different banks or ranks of keys, so that they act together when one is played upon. When a key of the lower bank is touched, it actuates the one above; but the action is not reciprocal. The coupler is thrown into action by a draw-stop or pedal.

Octaves in the same bank are sometimes coupled, to avoid the necessity of striking octaves by stretching the hands. Similarly, the *great*-organ may be coupled with the *choir*-organ or the swell.

2. The ring which slips upon the handles of a crucible tongs, or a nipping-tool of any kind. Also called *reins*.

Coup'les. (*Carpentry.*) Rafters framed together in pairs by a tie, which is generally fixed above the feet of the rafters.

Main couples; the roof-trusses.

Coup'ling. A device for uniting adjacent parts or objects. See under the following heads: —

Axle-coupling.
Bale-tie.
Ball and socket.
Band-coupling.
Bayonet-joint.
Belt-clasp.
Belt-coupling.
Belt-fastener.
Binding-screw.
Bolster-coupling.
Buckle.
Car-coupling.
Carriage-coupling.
Carriage-shackle.
Chain-coupling.
Clasp.
Claw for suspending tackle.
Clevis.
Clinch-ring.
Clip.
Clutch.
Clutch-rope.
Coat-link.
Connecting-link.
Connector.
Coupler.
Coupling-box.
Coupling-link.
Coupling-pin.
Coupling-pole.
Cramp.
Differential coupling.
Draft-bar.
Draw-bar.
Draw-link.
Expansion-coupling.
Felloe-coupling.
Fetter.
Fish-bar.
Fish-joint.
Flexible coupling.
Friction-clutch.
Friction-coupling.
Gimbal.
Gimmal.
Gland.
Grappling-iron.
Gripes.
Gyves.
Hame-fastening.
Hand-clamp.
Hand-cuff.
Harness-snap.
Hasp.
Hinge.
Hook (varieties, see HOOK).
Hopple.
Hose-coupling.
Jew's-harp-shackle.
Joint (varieties, see JOINT).
Joint-coupling.
Key-coupler.
Knuckle-joint.
Lap-ring.
Lengthening-rod.
Link.
Manacles.
Oldham's coupling.
Open ring.
Parral.
Perch.
Pipe-coupling.
Pitman-coupling.
Rail-coupling.
Reach.
Reins.
Ring.
Rod-coupling.
Screw-coupling.
Shackle.
Shaft-coupling.
Shank-coupling.
Snap-hook.
Snap-link.
Spiral-spring coupling.
Split-pin.
Split-ring.
Spring-coupling.

Swivel.
Thill-coupling.
Tool-coupling.
Tree-coupling.
Truss.
Turnbuckle.
Universal joint.
Wagon-coupling.

Coup'ling-box. A metallic box into which the ends of two shafts are fastened, to couple them in line.

Coup'ling-link. An open or split link for connecting two objects, or forming a detachable section in a chain.

Coup'ling-pin. (*Vehicle.*) A bolt which fastens the hind hounds to the coupling-pole, which is attached to the fore-gears by the king-bolt.

Coup'ling-pole. (*Vehicle.*) A pole connecting the fore and hind gear of a wagon.

Coup'ling-strap. A strap connected to the off bit-ring of the off horse, thence through the near bit-ring, and leading back to the harness of the near horse. Used with artillery horses, and also for restive horses in ordinary service.

Cou-pure'. (*Fortification.*) A passage cut through the glacis in the reëntering angle of the covered way, to facilitate sallies by the besieged. They are sometimes made through the lower curtain, to let boats into a little haven built in the reëntering angle of the counterscarp of the outworks.

Course. 1. (*Masonry.*) One row or tier of bricks or stones in a wall.

Plinth-course; a lower, projecting, square-faced course.

Blocking-course; laid on top of the cornice.

Bonding-course; one in which the stones lie with their length across the wall.

Heading-course; being all headers.

Stretching-course; consisting of stretchers.

Springing-course; upon which an arch rests

String-course; a projecting course in a wall.

Rows of slates, tiles, and shingles are also termed *courses*. The *barge*-course is one projecting over the gable of a building.

2. (*Music.*) A set of strings of the same tone placed alongside, and struck one, two, or three at a time, according to the strength of sound desired. The adjustment in a piano is made by the *soft* pedal, which shifts the bank of keys.

3. (*File-cutting.*) A row of parallel teeth on the face of a file. One *course* makes a *single-cut* file. A *course* crossing the former at right angles constitutes it a *double-cut* file.

Eight *courses* of cuts are required for a square file, *double-cut* on each side.

On the half-round files for *gulleting* saws as many as twenty-three *courses* are required for the convex side, and only two for the straight side.

4. (*Mining.*) The direction of a vein or lode.

Coursed Ma'son-ry. As distinguished from *pierre perdue*, in which the stone is cast in at random to make a foundation, as in the Plymouth and other breakwaters, the Rip-raps, etc. *Coursed masonry* consists of blocks lying on their beds in *courses*. When laid beneath the surface of the water, they are directed by operators in the diving-bell, as practiced by Smeaton at Ramsgate Harbor.

Coursed-rubble masonry is laid in courses with occasional headers; the side joints are not necessarily vertical, nor the stones in a course of an even thickness.

Cours'es. (*Nautical.*) The sails sustained by the lower masts; as the foresail, mainsail, and spanker.

Cours'ing-joint. The mortar-joint between two courses of bricks or stones.

Court-plas'ter. Silk surfaced with a solution of balsam of benzoin.

Cous'si-net'. (*Architecture.*) The impost stone on the top of a pier. *Cusheon.*

Cove. 1. (*Architecture.*) *a.* A hollow forming a member of some cornice-moldings or ceiling-ornamentation.

b. The concavity of an arch or ceiling.

2. (*Shipbuilding.*) An arched molding at the foot of the taffrail. An elliptical molding sprung over it is called the *arch* of the cove.

Coved Ceil'ing. One with a hollow of about a quarter-circle running round the room, situated above the cornice, and dying into the flat central portion.

Cov'er. 1. (*Roofing.*) That portion of a slate, tile, or shingle which is hidden by the overlap of the course above. The exposed part is the *margin*.

2. (*Machinery.*) The *cap-head* or end-plate of a cylinder.

3. A lid or hatch for a coal-hole, cistern, or vault-opening.

4. A turret or cupola on a kitchen or boiling-house, pierced at the sides to let out steam or smoke.

5. (*Steam-engine.*) The lap of a slide-valve. See LAP.

Cov'ered Way. (*Fortification.*) A sunken area around a fortification, of which the glacis forms the parapet. A *banquette* on the interior slope of the glacis affords a place for the garrison to stand on while delivering a grazing fire over the *glacis*.

Cov'er-ing. (*Bookbinding.*) The clothing of the sides and back of a book with cloth, muslin, leather, paper, or other material. The cover ready for the contents is a *case*.

Cov'er-ing-strap. (*Iron Shipbuilding.*) A plate beneath the two meeting plates in a strake, to which they are riveted and by which they are connected.

Co-vet'ta. A plane used for molding framework, called also a *quarter-round*.

Cov'ing. (*Architecture.*) *a.* The overhang of the upper portions of a building beyond the limits of the ground plan.

b. The splayed reveals or inclined jambs on the sides of a fireplace. These jambs were square in the old English fireplaces. In some of the Louvre fireplaces the jambs have an angle of about 45°. These were probably erected about 1750, by Gabriel, under the orders of M. de Mavigny. Gauger had previously (1715) given to the coving a parabolic curve. Count Rumford invented or adopted the inclined coving, having an angle of 135° with the fire-back, to radiate heat into the room.

Cow. 1. (*Mining.*) A wooden wedge to jam against the barrel of a *gin* or *crab*, to keep it from revolving. (Prov. Eng.)

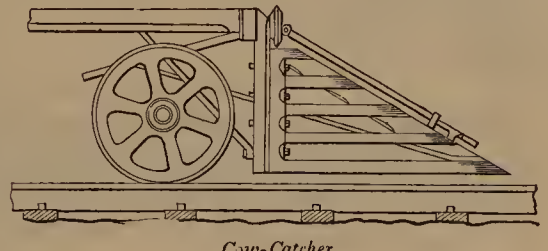
2. A kind of self-acting brake formerly used on inclined planes. A *trailer*.

Cow'an. A Scotch fishing-boat.

Cow-beck. A mixture of hair and wool for hats.

Cow-catch'er. An inclined frame in front of a

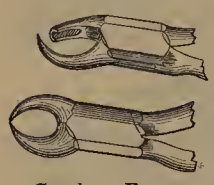
Fig. 1495.



Cow-Catcher

locomotive, to throw obstructions from the track. A *pilot*. Patented in England by Lindo, 1840.

Fig. 1496.



Cow-horn Forceps.

Cow-horn For'ceps. A dentist's instrument for extracting molars. That for the upper jaw has one hooked prong like a cow's horn, the other prong being gouge-shaped.

The cow-horn forceps for the lower molars has two curved prongs, which hook between the pairs of side-roots of the molar.

Cowl. A chimney-cap made to turn around by the wind, or provided with ducts by which the wind is made an accessory in educting the smoke and other volatile products of combustion.

A wire cap or cage on the top of a locomotive smoke-stack.

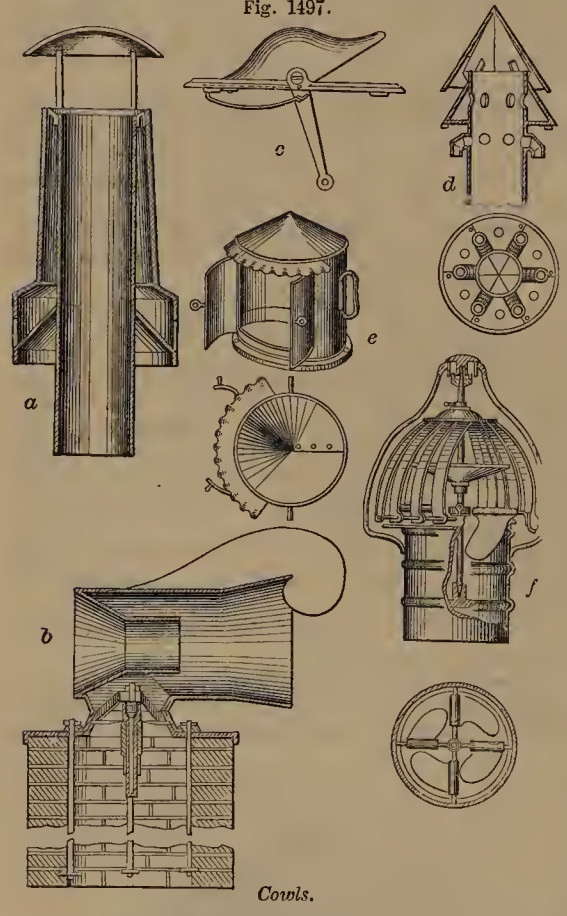
Cowls are also used on the summits of ventilating shafts for public buildings.

a (Fig. 1497). The flue has enveloping side passages which assist the draft by induction.

b. The spindle of the cowl is stepped in a socket, its collar revolving in flanges upon the upper side of the cap-plate, which is anchored to the brick-work of the chimney.

c is a cowl or hood for a car-roof, and has an adjustment by which its mouth is presented in either direction to lead in vital air, or by induction to expel foul air.

Fig. 1497.



Cowls.

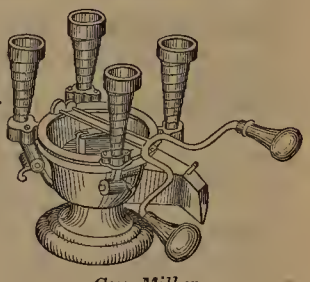
d has a circular series of openings to encourage upward draft, a deflecting frustum, and conical cap.

e is a cover for a marine stove-pipe. It is adjusted by hand so as to present the opening to leeward, and the side-wings are held open by the top-shield, which is pressed down upon them.

In *f*, the issuing current of air and smoke is deflected outward by the cone, and impinges upon the obliquely set plates of the fan-cap, causing it to revolve.

Cow-milk'er. A mechanical device for milking cows. The usual devices are on the principle of the breast-pump, with cups for the several teats. The elastic cups communicate with the conical cylinder of the diaphragm pump, the piston of which is worked by the handles. The milk is discharged by a spout into a pail beneath.

Fig. 1498.



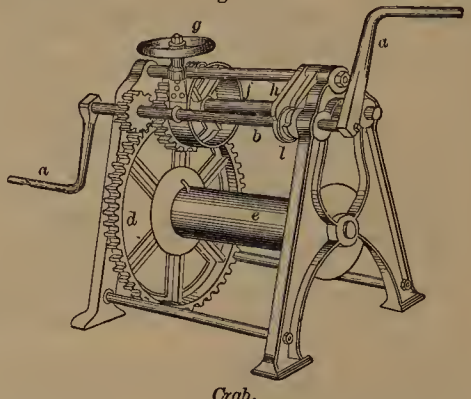
Cow-Milker.

Cown'er. The arched part of a ship's stern.

Crab. 1. A winch on a movable frame with power-gearing, used in connection with derricks and other non-permanent hoisting-machines.

The larger gear-wheel is on the shaft of the roller, and is rotated by the spur-pinion and hand-cranks.

Fig. 1499.



Crab.

2. A form of windlass for hauling ships into dock.

3. A machine used in ropewalks to stretch the yarn.

4. A claw for temporarily anchoring to the ground a portable machine.

Crack'er. 1. (*Pyrotechnics.*) A form of explosive fire-work. Marcus Græcus, in the eighth century, speaks of a composition of sulphur, charcoal, and saltpeter, which he said might be made to imitate thunder by folding some of it up in a cover and tying it tightly. This was a *cracker*.

2. A hard-baked biscuit. See BISCUIT.

3. One of the deeply grooved iron cylinders which revolve in pairs and grind the tough, raw caoutchouc, which has been previously cut in pieces by a circular knife.

Cra'dle. 1. A baby's bed or cot, oscillating on rockers or swung upon pivots.

The ancient Greeks used cradles, and called them by names indicating their forms, such as little bed, boat, etc.

Baby cradles were used by the Romans. They are mentioned by Theocritus. The cradle of Henry V. of England swung between two posts.

2. A thin shell or case of wood, acting as a splint for a broken bone or dislocated limb.

3. A framework which supports the bedclothes above an injured limb.

4. A frame on which loam-molds are placed in an oven to be burned, after the spindle is withdrawn.

5. (*Hydraulic Engineering.*) The frame in which a ship lies on the ways, and which accompanies her in launching; or, the frame in which a vessel lies on a way or slip, or in a canal-lift.

A cradle was used in very early times in crossing the Isthmus of Corinth, from the Corinthian to the Cenchrean Sea. The place was called the *Diolcos*, or drawing-place, and was five miles in length. This crossing-place was again used during the maritime warfare between the Genoese and the Turks.

At a number of places in Lombardy and Venetia the locks are insufficient or absent, and boats are cradled and transported over the grade.

The same thing takes place on the Morris and Essex Canal, which crosses the State of New Jersey, uniting the Hudson and Delaware Rivers. See INCLINED PLANE.

In its simple form, the cradle consists of three longitudinal timbers united by ribs or cross-pieces. This is floated beneath the ship, which is lashed thereto by cables. The cradle and its burden are then floated to the inclined ways or slip, up which it is hauled, being supported by rollers which intervene between the timbers of the cradle and those of the slip.

6. (*Metallurgy.*) A rocking apparatus, used in collecting gold from soil and sand by agitating the auriferous earth in water.

The earth is shoveled into the sieve, and washed through its meshes by water, which also carries off

Fig. 1500.

Gold-Washing Cradle.

the lighter earthy particles in suspension. The coarser matters, which do not pass the meshes of the sieve, are thrown out and the operation repeated. After a large quantity of earth has been thus disposed of, the contents of the cradle are washed in a pan and the gold obtained from the settlings.

7. A tool used by *mezzotint*-engravers. It consists of a steel plate with a proper tang and handle, and has angular grooves on its under surface, so that when the rounded end is obliquely ground, it will form a row of points by which a multitude of burrs are raised upon a plate. This is the mode of proceeding in MEZZOTINT-ENGRAVING (which see), the cradle being rocked back and forth, and retreating, making a zigzag series of burrs. This is crossed at right angles, and then several times diagonally, until the whole surface of the plate is roughened, so as to hold the ink of the copper-plate printer. The burnisher and scraper remove the burr in parts, according to the desired graduation of lights.

8. A suspended scaffold used by miners.

9. (*Carpentry.*) The rough framework or bracketing forming ribbing for vaulted ceilings and arches intended to be covered with plaster.

Fig. 1501.

British Cradle.

10. (*Husbandry.*) *a.* A set of fingers projecting from a post which is mortised into the snath of a grain-scythe.

b. A grain-scythe.

The American grain-cradle is a superior implement. The English *cradle-scythe*, judging by the representations, is a far inferior tool; nothing in its execution comes up to the rate and quality of work as seen in the American harvest-field before cradles were superseded.

Cra'dle-scythe. (*Agriculture.*) A broad scythe to be fitted in a grain-cradle, as distinguished from a *grass* or *mowing* scythe.

Cra'dling. 1. (*Coopering.*) Cutting a cask in two lengthwise, in order to allow it to pass through a doorway or hatchway, the parts being afterwards united and rehooped.

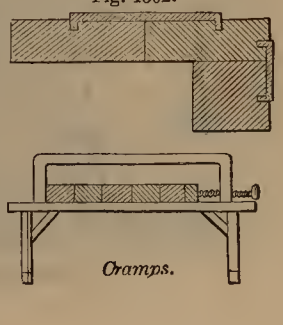
2. (*Carpentry.*) The framework in arched or coved ceilings to which the laths are nailed.

Cramp. 1. (*Masonry.*) A bar of iron with bent ends, used to unite adjacent blocks of stone in situations where they are exposed to wrenching, as in piers, wharves, lighthouses, breakwaters, etc.

The stones forming the piers of the bridge of Semiramis across the Euphrates, at Babylon, were secured together by iron cramps fastened by melted lead. So said Diodorus Siculus.

Cramps of lead for fastening together the stones of masonry were found by Layard among the ruins of Nineveh. Leaden cramps were similarly used in Egypt.

Fig. 1502.



Cramps.

The blocks included in one layer of masonry in Smeaton's Eddystone lighthouse were united by iron cramps, with melted lead poured around them. Wooden dowels united the layers.

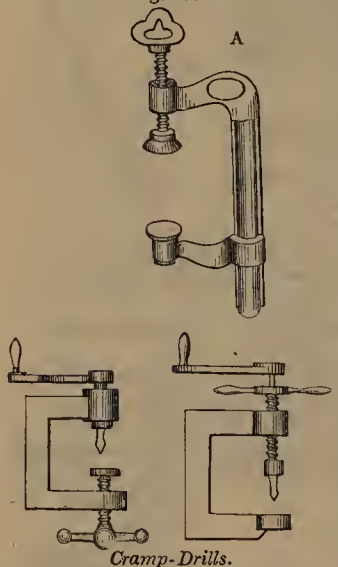
The stones in the Coliseum of Vespasian were united by bronze cramps.

2. (*Carpentry.*) *a.* A rectangular frame with a tightening screw, by which carpenters compress the joints of framework, as in making doors and other panel-work, and for other purposes. Its office is somewhat similar to that of a *clamp*.

b. A bench-hook or hold-fast. (A, Fig. 1503.)

3. (*Bootmaking.*) A piece of board, shaped like the front of a boot, over which leather is bent to form the upper of a boot or shoe. See CRIMP.

Fig. 1503.



Cramp-Drills.

Cramp-drill. A portable drill having a cutting and a feeding motion. In one of the examples the feed-screw is in the lower member of the cramp-frame, and in the other one it is in the upper portion and forms a sleeve around the drill-spindle which rotates within it.

Cramp-i/ron. An iron binding two stones together in a course. It has usually turned-over ends which penetrate the respective ashlars. See CRAMP.

Cramp-joint. One in which the parts are bound together by locking-bars. See CRAMP.

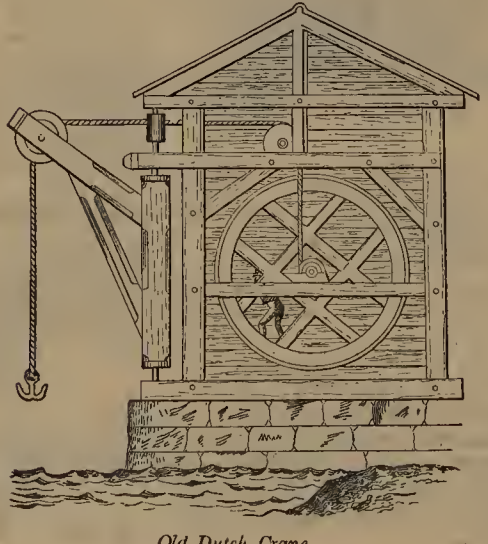
Cram/poons. 1. A clutch formed like a pair of calipers, used in raising objects.

2. Iron spikes worn on the boots, to assist the foothold in climbing the slopes of earthworks.

Cran/ber-ry-gath/er-er. An implement shaped like a rake, and adapted to catch below the berries on the stalk, and collect them in a bag or box attached to the rake-head.

Crane. 1. A machine for hoisting and lowering heavy weights. It consists of a vertical post or frame, which is rotatable on its axis, and a jib or projecting arm over which the chain or rope passes on its way from the winch at the foot of the post to the load to be lifted.

Fig. 1504.

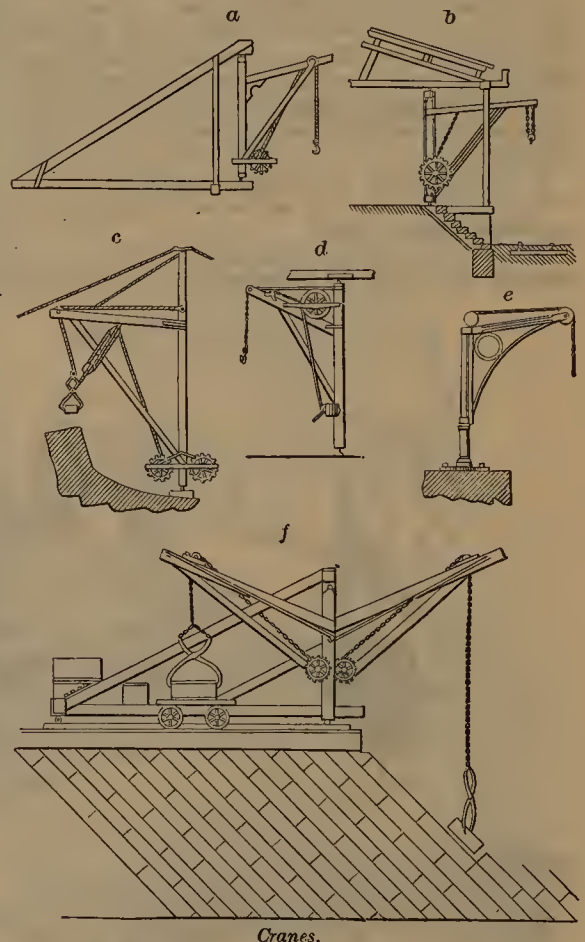


Old Dutch Crane.

The *corvus* of the Romans, which has been translated *crane*, was a boarding device, consisting of a ladder attached to a vertical spar and so pivoted as to bring the outer end over the deck of the ship to be boarded. A grappling-hook was suspended from the end of the staging. By this means of approach the Romans boarded the Carthaginian vessels, and achieved success in several naval engagements. A *corvus* was also used as a true crane for picking off soldiers garrisoning a city wall, and setting them down outside. It is described by Tacitus: —

"The stones of the pyramids were raised by making mounds of earth; cranes and other engines not being known at that time." — DIODORUS SICULUS (60 B. C.).

Fig. 1505.



Cranes.

The old Dutch crane, which was also in use in England till the early part of the present century, was operated by a tread-wheel, around which the rope was wound; the rope then passed over guide-rollers to the jib of the crane, which projected over the hatchway of the ship and turned upon a pivot, so that it could move round about three fourths of a circle, and so deliver the goods upon the quay.

In order to lower the goods the men walked backward; but as it sometimes happened that they were overbalanced by the descending weight, a bar or pole of wood was suspended from the axle, so that in such case they might lay hold of it, and save themselves from being whirled round in the wheel.

The great wheel and the framing which supported

it were contained in a wooden building, to the corner of which the jib was attached.

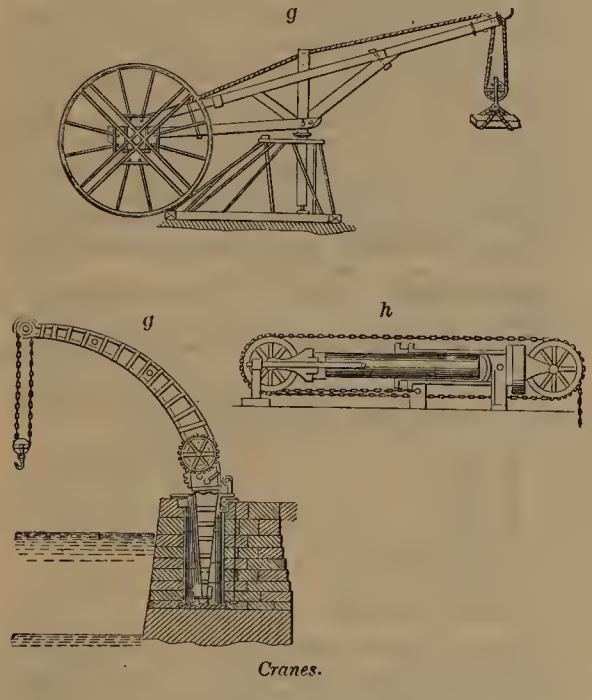
The essential features of a crane may be combined in a machine of simple construction (Fig. 1505), the central pillar being sustained by a frame of timber *a*, by a planted pillar *b*, or by guys *c*, as in the three examples of cranes of simple construction. The operation is sufficiently plain without entering into detail.

The ordinary warehouse or foundry crane (*d*, Fig. 1505) is usually stepped in the floor, and has its upper bearing in a joist or beam. Its size, proportions, and to some extent its construction, depend upon its place and application.

The application of iron in the construction of the crane causes some change in the appearance *e*, apparent lightness and compactness being gained.

The double crane (*f*, Fig. 1505) has two jibs; one of which is employed in raising a load, while the other is depositing its load in position. The crane is mounted on a carriage traversing on rails or rollers, and in the illustration is shown as applied to laying stones on a breakwater. Each jib has a

Fig. 1506.



Cranes.

sliding carriage over which the chain passes, so that the stones may be deposited either near to or farther from the shaft of the crane. This carriage is worked by a sheave and rope which passes over the point of the jib and down by the side of the spindle. The crane rotates horizontally on an axis, to bring the jibs over the places for receiving and depositing the stones respectively.

Peronnet's crane, French, (*g*, Fig. 1506,) was used by him in constructing the bridge of Neuilly. It was constructed of wood, and worked by two large wheels which had hand-pins whereby they were turned. The spindle or vertical shaft was journaled and stepped in a movable frame, and the hoisting-wheels formed a partial counterpoise for the load suspended from the end of the jib.

Fairbairn's tubular crane (lower figure *g*) is made of wrought-iron plates riveted together, and arranged so as to give the convex back and upper sides a sufficient degree of strength to resist tension, while the concave side has a cellular structure to resist compression.

Cranes were worked by hydraulic pressure as early as 1846, at Newcastle, England; subsequently the lock-gates and cranes of the Albert Dock, Liverpool, and those of the Grimsby Dock, were worked by water, derived either from the town-reservoirs or from elevated reservoirs into which it was pumped for that special purpose.

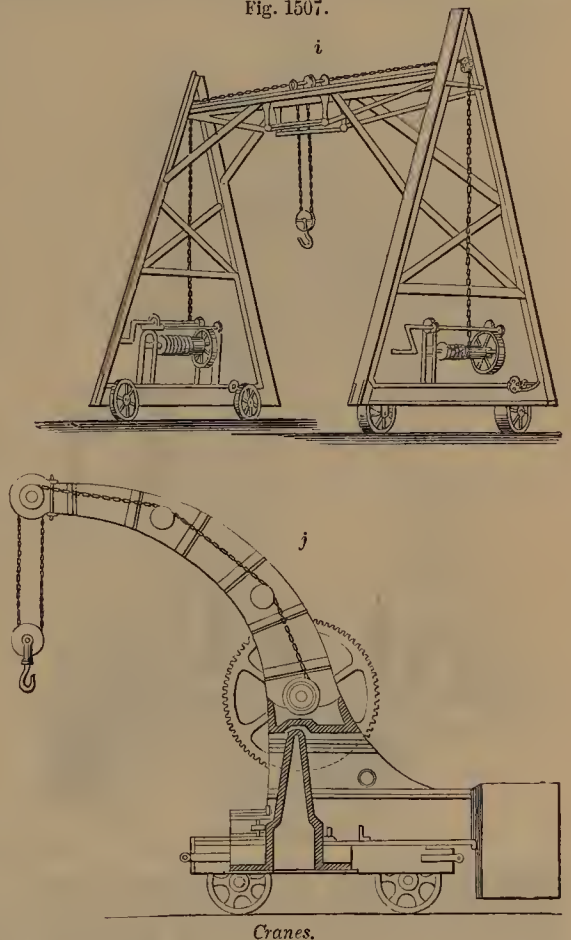
These sources, being fluctuating or expensive, gave rise to the adaptation of machinery for the purpose.

Armstrong's hydraulic crane, English, 1854 (*h*, Fig. 1506), consists of one or more hydraulic presses, with a set of sheaves used in the inverted order of blocks and pulleys, for the purpose of obtaining an extended motion of the chain from a comparatively short stroke of the piston.

In the illustration, the motion is multiplied threefold, each block having two sheaves.

Swinging the jib is effected by means of a rack or

Fig. 1507.



Cranes.

chain operating on the base of the movable part of the crane, and connected either with the cylinder and piston, having alternate motion like that of a steam-engine, or with two presses applied to produce the same effect by alternate action.

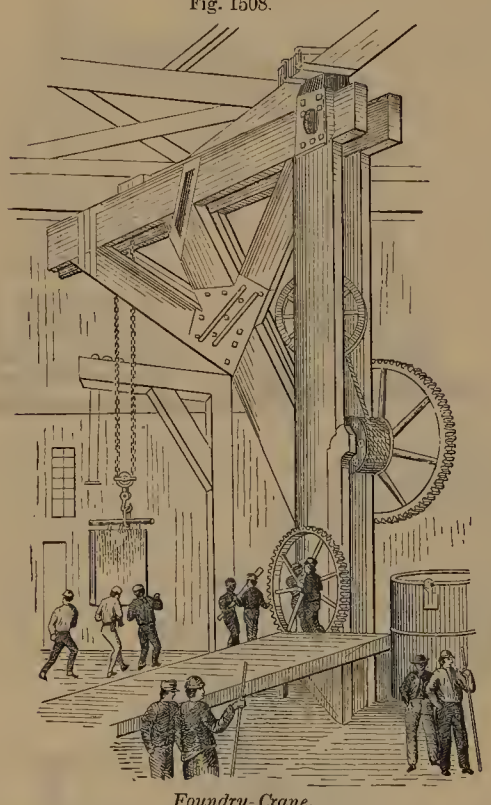
Armstrong's accumulator is intended to store the power exerted by the engine in charging it, and consists of a reservoir giving pressure by load instead of by elevation. It is a large, cast-iron cylinder fitted with a plunger, from which a heavy load-case is suspended. Water is injected by the engine, raising the plunger and the load, the effective weight of which is utilized in ejecting the water as it may be occasionally called for.

The power thus exerted in the ejection of water from the engine is usually equal to a column of water 1,500 feet high. See ACCUMULATOR.

A form of crane (*i*, Fig. 1507) traveling upon a wide-gage railroad, and bearing its load suspended from a beam above, has been adopted in some yards where heavy timber, stone, or iron require to be moved, loaded, and unloaded. The hoisting-chains are worked by winches on each section, and pass over a truck above, which has traverses on the beam, so as to bring the hook over a load nearer to or farther from the rails. By means of the traveling motion of the machine on the rails and the traversing motion of the truck above, the hook of the chain may be brought over any part of the space within the rails. If both windlasses be turned at once, the load rises. If one be unwound while the other is winding, the hook does not rise, but the truck traverses.

Fairbairn's traveling crane (*j*, Fig. 1507) is adapted for a wrecking-crane for railroad use. A crane

Fig. 1508.



Foundry-Crane.

adapted for lifting fifteen tons will have a counterweight of ten tons in the rear. In the example from which the illustration is derived, the jib swept over a circle of 25 feet diameter, and was capable of lifting the load 18 feet above the rails on the beam above, towards the winding side. By turning or unturning the respective windlasses at the necessary speeds relatively, a compound motion may be attained, towards or from either rail upward or downward.

One form of *traversing-crane* consists of a *crab* upon a carriage traveling upon rails on the beams overhead in a foundry. By the rotation of the roller of the crab, the chain or rope is wound on and the load lifted, and by the motion of the carriage is transported to any place within the range of the rails. It is known as an *overhead* crane.

The foundry-crane has a traversing carriage on the jib, which permits the point of suspension to be moved out or in from the central post; the range being from the outer end to the mid-length of the jib. The traversing-carriage is moved by an endless chain descending to the floor of the foundry.

In Morrison's steam-crane, the crane-post forms the steam-cylinder, and is fitted with a piston having a flexible piston-rod of wire rope, which works steam-tight through a stuffing-box at the top, and passes over two pulleys, itself forming the chain for lifting the load.

The downward stroke only of the piston is utilized in lifting, and the steam induction and eduction are governed by slide-valves operated by hand-levers.

In Evans's steam-crane, a vertical boiler forms the crane-post and revolves with it. The cast-iron top of the boiler has lugs for the attachment of the tension-rods. An oscillating cylinder is attached and furnishes the power.

The projecting arm or beam of a crane is the *jib*.

The *post* and *jib* collectively are sometimes known as the *gibbet*.

The diagonal is the *stay*.

2. (*Nautical.*) *a*. A forked post to support a boom or spare spar on deck.

b. A projecting bracket to support spars, etc.

3. An overhanging tube for supplying a tender with water. A water-crane.

4. A contrivance to hold a stone, and present it to the slicer of the lapidary.

It consists of a clamp which moves horizontally, having its bearings on a vertical post rising from the bench of the lapidary. A weighted string is attached to the lever-arm, and keeps the stone constantly pressed up against the slicer. See SLICER.

Crane, Der'rick. A form of crane having spars for jib and post. See DERRICK.

Crane's-bill. (*Surgical.*) A pair of long-nosed pinchers.

Cra'ni-om'e-ter. An instrument for measuring sizes of skulls.

Dr. Morton gives the following as the average result of numerous measurements of skulls: —

European	87	cubic inches.
Malay	85	" "
Negro	83	" "
Mongol	82	" "
Ancient Egyptian	80	" "
American	79	" "
Ancient Peruvian	75 to 79	" "

Professor Huxley says that the most capacious European skull has a capacity of 114 cubic inches; the smallest, 55 inches. Schaaffhausen finds Hindoo skulls of 46 cubic inches.

Cra'ni-o-tome'. A cutting instrument for opening the fetal head, to assist delivery.

Crank. An arm (called the *web*) at right angles to an axis by which motion is imparted thereto or received therefrom. The crank on the axis of a grindstone or a fanning-mill is a familiar instance.

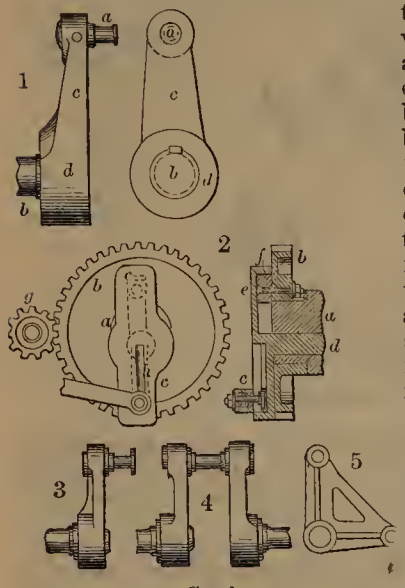
The crank is also a valued device in converting a rotary into a reciprocating motion, or conversely. An example of the former is found in the saw-mill; of the latter, in the steam-engine. Watt is the inventor of the latter application of it.

3 (Fig. 1509) shows the *single*-crank; 4, the *double*-crank; 5, the *bell*-crank.

1 (Fig. 1509), *a*, wrist or pin; *b*, shaft; *c*, web; *d*, boss.

James Watt — no mean judge — remarks that "the true inventor of the crank rotative motion was the man, whose name, unfortunately, has not been preserved, who first contrived the common foot-lathe.

Fig. 1509.



Cranks.

The applying to the steam-engine was merely taking a knife to cut cheese which had been made to cut bread." It was a meritorious application, however, devised by Watt, to turn the reciprocating action of the piston into a rotary motion, and was stolen from him by a man who spied out the design from a sketch and conversation of Watt's workmen. Watt invented the SUN AND PLANET MOTION as a substitute (which see). See also PLANET-WHEEL AND EPICYCLOIDAL WHEEL. If the foot-lathe were the earliest form of lathe, which is not certain, and James Watt's idea were correct, which is quite probable, we may agree with one authority that the crank is as old as Talus, the grandson of Dædalus, about 1240 B. C.; or, according to Pliny, Theodorus of Samos, about 600 B. C. It must be recollected, however, that among the oldest Egyptian paintings is the representation of Thoth forming man upon the potter's wheel.

The crank was first used with the steam-engine on board the paddle-wheel steamboat of Jonathan Hull (English patent, December 21, 1736, No. 556). It did not revolve, but reciprocated, and formed an intermediate between the rope, which was pulled by the descent of the piston, when a vacuum was created in the Newcomen atmospheric engine and the leg of the propeller, which seems to have acted somewhat like the leg of a grasshopper.

A four-throw crank was employed on each end of the axis of the wallower or lantern-wheel, which was driven by the water-wheel under the north arch of London Bridge, as described by Beighton, 1731. This machine supplied a part of London with water. The water-wheel was first placed there by Morice in 1582, but it is not stated by what device the rotary motion of the wheel was converted into the reciprocating motions of the pistons in the six pumps which were operated by it.

2 (Fig. 1509) shows a combination of crank and eccentric. The boss *a*, on which turns the spur-wheel *b*, is fixed. The crank *c* turns with the spindle *d*, which is fitted eccentrically in the boss *a*. The pin *c* with the block *f* are fixed to the spur-wheel, which is set in motion by the pinion *g*. In revolving round, this wheel carries with it the crank; but, owing to the eccentricity of the two centers, the block *f* slides down the slot in the crank, and in so doing approaches nearer to the center on which the latter revolves. This has the effect that, as the angular velocity of the spur-wheel is constant, it will cause different points in the radius of the crank *consecutively* to revolve with the same linear velocity; or, in other words, will cause the angular velocity of the crank gradually to *increase* during one half of the revolution, and gradually to *decrease* during the other half. The stroke of the crank may also be varied by shifting the crank-pin in the slot *h*.

A two-throw or *three-throw* crank-shaft is one having so many cranks set at different angles on the shaft.

Crank-axle. 1. An axle bent down between the wheels, in order to lower the bed of the wagon and make loading more easy.

It has been introduced in England for country and city wagons, and also in the United States. It is credited to Baddeley, an early contributor to the London "Mechanic's Magazine."

2. (*Steam-engine.*) The driving-axle to which are connected the piston-rods of a locomotive engine. This is the usual English form; in America we connect to wrists on the drive-wheels.

Crank-brace. The usual form of brace, which has a bent shank by which it is rotated.

Cranked Tool. (*Iron-turning.*) A tool which is made to embrace the rest *a*, by which it is prevented from slipping away from the work. A pin is inserted in one of the holes in the rest, to prevent the escape of the tool sideways. The direct penetration is obtained by depressing the handle; the lateral motion by rotating the tool by its transverse handle, which may be a hand-vise temporarily screwed upon the shaft, or a shoulder-rest handle, as in the illustration of *heel-tool*.

Fig. 1510.

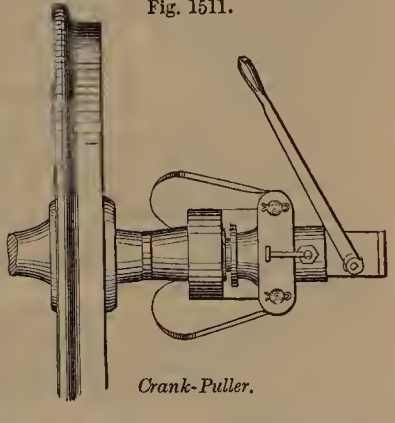
Cranked Tool.

Crank-hook. The bar connecting the treadle and crank in the common foot-lathe.

Crank-pin. A pin connecting the ends of a double crank or projecting from the end of a single crank. In either case it is for the attachment of a pitman or connecting-rod. (See *a*, 1, Fig. 1509.)

Crank-puller. A machine for pulling the crank off an axle or shaft.

Fig. 1511.



Crank-Puller.

Fig. 1511 shows a hydraulic crank-puller which is portable, and therefore applicable to work *in situ*. It is shown as constructed with a 4-inch ram, and capable of exerting a force of forty tons.

Crank-shaft. A shaft driven by a crank, such as that of the grindstone.

Crank-wheel. A wheel having a wrist to which a pitman or connecting-rod is attached, and acting as a crank, while the peripheral portion may act as a fly-wheel, or may constitute a pulley or a traction-wheel.

Cran'ny. (*Glass-manufacture.*) A tool for forming the necks of glass bottles.

Crape. (*Fabric.*) A gauzy fabric made of raw silk, and woven without crossing.

Uncolored, or gayly dyed, it is a rich shawl-stuff.

Colored black and crimped, it is a mourning-goods. Smooth crape is used in ecclesiastical habits of a certain order, not quite so elevated as the cambric lawn of a bishop.

"A saint in *crape* is twice a saint in *lawn*."

The latter is the superlative degree of ecclesiastical habiliments in *reformed* churches.

Crisped crape denotes a poignant grief; the change

to a smoother class of goods indicates that the merciful hand of Time has burnished out the wrinkles and lines of care.

Silk intended for crisp crape is more twisted than that for the smooth. The twist of the thread, especially that of the warp, is what gives the wrinkled appearance to the goods when taken out of the loom.

Aërophanes and *gauze* are goods of a similar description, either white or colored.

Crape is said to have been made by Ste Badour, Queen of France, A. D. 680. It was first made at Boulogne.

Crape-mo-rette'. (*Fabric.*) A gauzy woolen fabric of fine texture, the warp being light and open, and the weft relatively heavy and fleecy. White or colored.

Crap'ing-ma-chine'. A machine by which silk is craped, i. e. crinkled.

Crap-leath'er. Leather made from thin cowhides. Used for pumps and light shoes.

Crare. A kind of coasting-vessel, now disused.

Crash. (*Fabric.*) A heavy, coarse, plain, or twilled linen toweling or packing-cloth.

Crate. A large wicker hamper with wooden supports, in which crockery-ware is packed for transportation.

Crates among the Romans corresponded to the English *hurdles*. They were of wicker-work, and were used for screens, for leveling ground after rough-raking (*rastrum*); also as *flakes* for drying fruit. The latter were sometimes made of sedge or straw.

Large crates were used in bridging fosses, protecting military engines, etc.

Crawl. A pen of stakes and hurdles on the seaside, for fish.

Cray. A small sea-vessel.

Cray'on. 1. A colored pencil consisting of a cylinder of fine pipe-clay colored with a pigment.

Black *crayons* are colored with plumbago, or made of Italian black chalk.

A white *crayon* is a cylinder of chalk, common in England and France. Red chalk is found in France.

The holder is a *porte-crayon*.

Crayons are said to have been made in France in 1422, and imported thence into England in 1748. It is hard to say how long ago charcoal, chalk, and ochreous earths were used.

Hans Holbein drew portraits in crayon in 1540. Sir Thomas Lawrence excelled in this style of portrait-painting, 1800–1830.

2. (*Lithography.*) A composition formed as a pencil, and used for drawing upon lithographic stones. It is of a soapy nature, consisting of soap, wax, resins, and lamp-black, melted, and sometimes burned, together.

Craze-mill. A grinding-mill for tin ore.

Craz'ing. The cracking of the glaze upon articles of pottery or porcelain.

Cream-freez'er. A domestic machine in which cream is stirred in a vessel plunged in a freezing mixture, usually of pounded ice and salt.

Cream-slice. A wooden knife for dividing and serving frozen cream.

Creas'er. 1. A tool used for making single or double lines on leather, to form guides or creases to sew by.

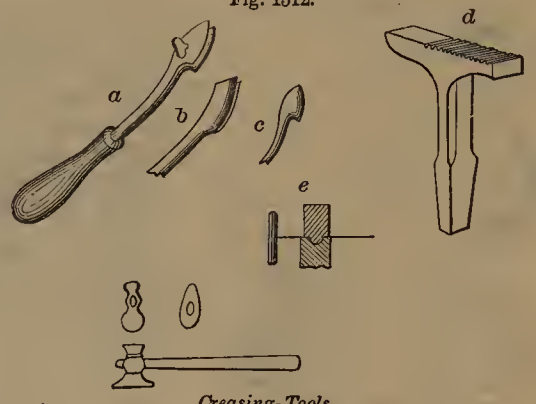
a, the adjustable double creaser, has two spring jaws, which are set open by means of a screw, so as to make the guide-lines at any required distance apart.

b is a double creaser without adjustability.

c is a single creaser.

They are also used for lining leather, to give it a finished appearance.

Fig. 1512.



Creasing-Tools.

2. *d* is used by sheet-iron workers for rounding small beads and tubes. Its shank has a tang by which it is secured in a square socket of the work-bench.

Top and *bottom creasing tools e*, of any suitable size and pattern, may be set in the jaws of a creasing-swage, the lower end of whose frame has a tang to set in the work-bench, while the upper hinged portion carries the top tool and is struck by a hammer.

The lower figure is a tool similar to the chisel, but having a blunt, rounded edge, employed by blacksmiths for making grooves in hot iron.

3. (*Bookbinding.*) A tool for making the band-impression distinct on the back.

4. (*Sewing-machine.*) An attachment which makes a mark in a line parallel with the work in hand, to indicate the place for the next seam or tuck.

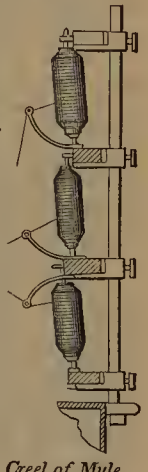
Creas'ing. A layer of tiles forming a corona for a wall.

Creas'ing Ham'mer. A narrow, rounded-edge hammer, used for making grooves in sheet-metal.

Creaze. (*Mining.*) The tin in the middle part of the buddle.

Creel. 1. (*Spinning.*) The bar which holds the paying-off bobbins in the *bobbin-and-fly*, the *throstle* machine, or the mule. In the first machine the bobbins hold the *sliver*, which is to be spun and twisted into a *roving;* in the latter machines, by a substantially similar operation, the *roving* is converted into *yarn*. The creel may have several bars with rows of skewers, upon which the bobbins are placed to unwind their contents.

Fig. 1513.



Creel of Mule.

2. A fish or root basket.

Creep. (*Mining-engineering.*) The curving upward of the floor of a gallery, owing to the pressure of superincumbent strata upon the pillars. Opposed to *thrust*, which is a depression of the roof.

Creep'er. 1. A four-clawed grapnel or drag, used in dragging the bottom of a harbor, pond, or well, to recover anything which has been lost overboard, or the body of a drowned person.

2. *a*. An iron bar connecting the andirons.

b. Small dogs, with low necks or none at all, used between the usual andirons to support brands above the hearth.

3. An endless, moving feeding-apron, or a pair of aprons arranged one above the other, having motion to feed fibers to or from a machine; *e. g.* the *creeper* which feeds the *sliver* or sheet of fibers from the doffer of a carding-machine. See LAP.

4. A small sole or piece carrying spurs, which may be attached to the boot, to prevent slipping on ice.

Creep'ing. (*Nautical.*) Dragging by grapnels for the recovery of a lost cable or rope.

The most remarkable instance on record is the recovery of the Atlantic cable, broken in mid-ocean.

Creep'ing-sheet. The feeding-apron of a carding-machine.

Cre-mail-lere'. (*Fortification.*) An indented horizontal outline.

Cre-mo'na. A violin of fine quality, named from *Cremona*, Italy.

Not to be confounded with the *cromorna* stop of an organ; named from the resemblance of its *timbre* to the German *krumm-horn*, a crooked horn.

Cren'e-lat'ed Mold'ing. A kind of molding in which the beads have rectangular dentations.

Cre-nelle'. (*Fortification.*) A loop-hole in a parapet wall or stockade through which to discharge musketry.

Cre'o-sote-ap-pli'ance. A dentist's instrument intended to prevent fluid caustics, such as creosote or solution of nitrate of silver, from running down and cauterizing the lips when being applied to the gums. A spiral platinum-wire carries the sponge, and a glass tube attached to the handle and surrounding the wire catches any of the caustic which may run down the wire.

Cre'o-sot'ing. A mode of preventing decay of timber by saturating with creosote. This is said to coagulate the albumen, absorb the oxygen, resinify in the pores of the wood and exclude air, and act as a poison to prevent fungi, acari, and other parasites.

Cre'pon. (*Fabric.*) A thin stuff resembling crape, made of wool, silk, or mixed.

Cre-quil'las. (*Fabric.*) A light, low-priced cotton fabric.

Cres'cent. A musical instrument, consisting of a staff with arms and suspended bells, used in a band.

Cres'set. 1. A basket of open iron-work in which wood or coal is burned as a beacon. It was

Fig. 1514.

Cresset.

formerly used where lighthouses are now erected, and its modern use is principally at wharves and boat-landings.

A hoisting arrangement for a cresset in which a beacon-fire is kept burning is shown in the illustration *B*. The pivots of the cresset *c* are above its center of gravity, so that it swings level, whatever may be the position of the mast. The mast itself is so pivoted as to swing 120° in a vertical plane, being operated by a winch and ropes. It is brought down within convenient distance, that the fire may be replenished, and is again elevated for service.

2. (*Coopering.*) An iron basket or cage *A* to hold fire, char the inside of a cask, and make the staves flexible.

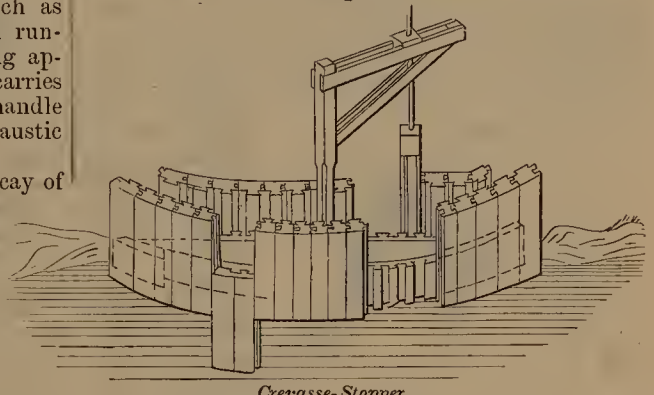
Crest. 1. The ridge of a roof; hence *crest*-tiles, which lie on the comb of the roof and shed water both ways.

2. The top of a parapet, embankment, slope, or wall. (See Fig. 2.)

Crest-tile. A saddle-tile, one having a double slope, on the ridge of a roof.

Cre-vasse'-stop'per. A kind of floating-dock which is brought broadside against the bank and

Fig. 1515.



Crevasse-Stopper.

sunk in place, to act as a dam. When it is fairly anchored, the sheet-piling is driven down into the bed both on the chord and arc side of the structure.

Crev'et. A crucible or melting-pot.

Crib. 1. A child's cot.

2. The rack or manger of a stable.

3. A granary with slatted sides for ear corn.

4. A reel for winding yarn (Scotland).

5. A small raft of timber (Canada).

6. A structure of logs to be anchored with stones. Cribs are used for bridge-piers, ice-breakers, dams, etc. See DAM.

Crib'bing. Internal lining of a shaft with frame-timbers and plank-backing, to prevent caving, stop percolation of water, etc. The different styles are known as *spiking-cribs*, *wedging-cribs*.

Crib'ble. (*Mining.*) A sieve.

Crib-strap. (*Menage.*) A neck-throttler for *crib-biting* and wind-sucking horses.

Cric. The inflecting ring which turns inward and condenses the flame of a lamp.

Crick. A small jack-screw.

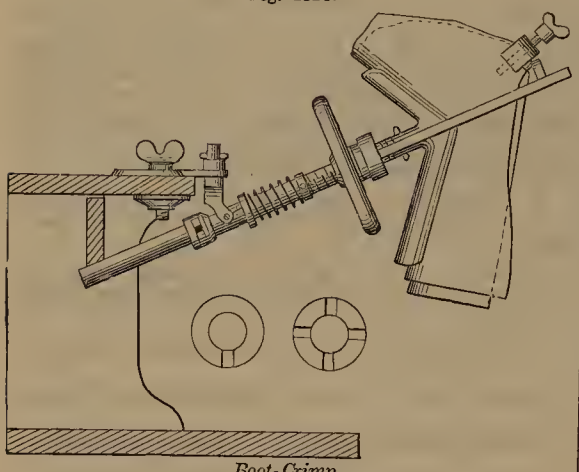
Crick'et. 1. An ancient English national game, said to be identical with the "club-ball" played in the fourteenth century.

2. A low stool, or a low table or portable shelf for kitchen uses.

Crimp'er. 1. (*Shoemaking.*) A curved board over which the *upper* of a boot or shoe is stretched, to give it the required shape.

In the common form the wetted leather is stretched by the pincers and by rubbing, and tacked on the edges to hold it till dry. Many patented boot-crimps have been introduced to expedite the process, as in the apparatus (Fig. 1516) which is

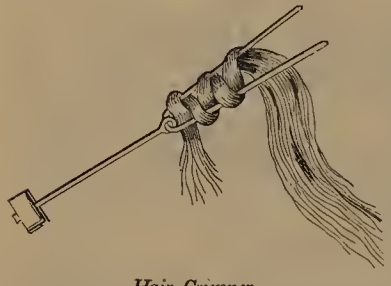
Fig. 1516.



Boot-Crimp.

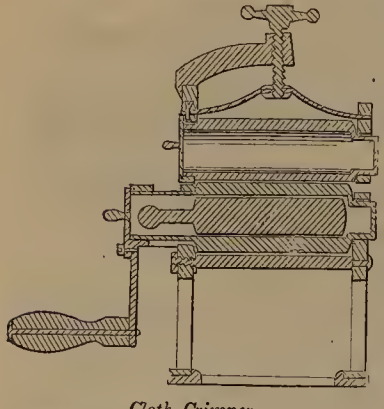
applied to the bench by a swivel-device, which permits the whole to be turned to the right or left as the work proceeds. The curved bar which supports the form upon which the leather is crimped has its groove lined with rubber, which prevents the wrinkling of the leather while undergoing the stretching process. A spiral spring is employed to hold together the two parts of a clutch, and thus retain the work rigidly in any position, but adapts the clutch to be disengaged to allow the shaft to be turned to bring the work in convenient positions for the operator. The yoke which clamps the form to its support can be adjusted at will, without interfering with its hold upon the form.

Fig. 1517.



Hair-Crimper.

Fig. 1518.



Cloth-Crimper.

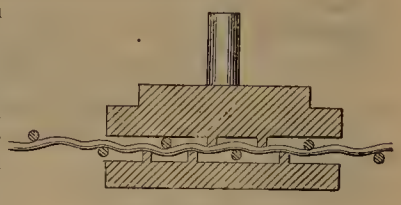
2. (*Toilet.*) A fork, a pair of needles, or a pinching device in which hair is braided to acquire a wavy appearance.

The hair-crimper (Fig. 1517) has a catch-bar pivoted to the bow of the hair-pin. The hair, being wound upon the two legs of the hair-pin, is pressed by the bar, and the latter clasped to the legs of the pin.

3. A machine for crimping or ruffling textile fabrics has usually a pair of fluted rollers between which the article is passed, as in the illustration, in which are two fluted cylinders, the lower in fixed bearings, the upper vertically adjustable; one or both being hollow for the reception of a heated iron.

4. (*Wire-working.*) A machine in which wire is given a sinuous form, to adapt it the more readily to take its position in woven wire-work.

Fig. 1519.

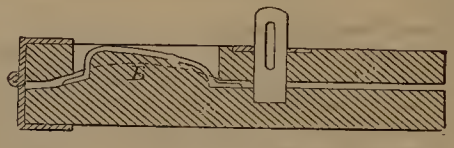


Wire-Cloth Crimper.

A machine in which wire cloth is crimped by pressure between dies, each of which has projecting teeth which come opposite the interdental spaces of the other die.

5. (*Saddlery.*) A press or break in which leather is molded into form between dies, as in the illustration, in which leather for a saddle-pad is placed on the bulbous portion *B*, and the hinged portion is brought down over it and locked in position till the leather is sufficiently dried to retain permanently its new shape.

Fig. 1520.



Pad-Crimp.

Crimp'ing-ma-chine'. See CRIMPER.

Crimp'ing-i'ron. An instrument for pinching, puckering, or fluting cap-fronts, frills, skirts, etc. See CRIMPER.

Crin'gle. (*Nautical.*) A rope made into a grommet and containing a thimble, and worked into the bolt-rope of a sail for the attachment of a bridle or other rope. The head-cringle is lashed by the head-earing to the strops on the yard-arm. The cringles on the leech are for the attachment of the *reef-tackle*.

Crin'o-line. (*Fabric.*) Originally, a horse-hair and cotton fabric for setting out a lady's skirts. The term is now commonly applied to the hoop-skirt, which has its periods of revival. Hoops were worn in 1740 three feet across the hips.

Crip'pler. A board with a corrugated under-surface and a strap above to hold it to the hand, used in *boarding* or *graining* leather, to give it a granular appearance and render it supple. The leather is folded with the grain side in contact, and rubbed on the flesh side with the *pommel*, which is another name for the *crippler*.

Crip'ple-tim'ber. Studding or scantling used in narrowing situations, where they are necessarily shorter than their fellows, as the *cripple-studding* from the rafters to the floor-joists in attics finished with a *collar-beam* ceiling. A *jack-timber*.

Crisp'er. An instrument for *crisping* the nap of cloth; *i. e.* covering the surface with little curls, such as with *petersham* or *chinchilla*. A *crisping-iron*.

Cris'tale. (*Fabric.*) A white worsted fabric.

Cro-chet'-lace. Hand-knitted lace.

Cro-chet'-nee'dle. A needle with a hooked end, used for catching the thread and drawing it through the loop in crochet-work.

Cro-chet'-type. Type with fancy faces, to set up in imitation of lace, crochet, or worsted work.

Crock'er-y-ware. See POTTERY; EARTHENWARE; PORCELAIN, etc.

Crock'et. (*Architecture.*) An upwardly projecting carved ornament on a Gothic gable or flying-buttress.

Cro'cus. A polishing powder composed of per-

oxide of iron. It is prepared from crystals of sulphate of iron, calcined in crucibles. The portion at the bottom, which has been exposed to the greatest heat, is the hardest, is purplish in color, and is called *crocus*. It is used for polishing brass or steel. The upper portion is of a scarlet color, and is called *rouge*. It is used for polishing gold, silver, and speculum metal. *Rouge*, the cosmetic, is made from safflower, or from carmine, which is a preparation of cochineal.

Croft'ing. Exposing linen on the grass to the influence of air and sunshine, after being *bucked* or soaked in an alkaline lye.

Cro-mor'na. (*Music.*) The *cromorna* or *krummhorn* is a reed-pipe stop of an organ, tuned in unison with *open-diapason*, and depending for the peculiar *timbre* or quality of its tone upon the shape and proportions of the tube through which the sound of the tongue is emitted. See STOP.

Croom. A husbandman's fork with long tines.

Crop. (*Mining.*) 1. Tin ore of the first quality, after it is dressed or cleaned for smelting.

2. The appearance of a vein or seam, as of ore or coal, at the surface. The *strike*.

Cropped. (*Bookbinding.*) A book cut so severely as to reduce the margin too much. When cut into the print, the book is said to *bleed*.

Cross. 1. (*Telegraphy.*) Accidental metallic connection between two wires on a line. — POPE.

2. (*Surveying.*) An instrument for laying off lines perpendicular to the main course.

Cross-ax'le. 1. A shaft, windlass, or roller worked by opposite levers; as the copper-plate printing-press, etc.

2. (*Railroad Engineering.*) A driving-axle with cranks set at an angle of 90° with each other.

Cross-bar Shot. Shot which folds into a sphere for loading, but on parting from the muzzle expands to a cross with sections of the shot at the extremities of the arms.

Cross-beam. A beam in a frame laid crossways. In a ship, a piece laid across heavy posts called *bitts*, and to which the cable is fastened when riding at anchor.

Cross-bear'er. The transverse bars supporting the grate-bars of a furnace.

Cross-bond. A form of bricklaying in which the joints of one stretcher-course come in the middle of the courses above and below.

Cross-bow. A weapon formed of a bow crosswise upon a stock. It is similar in kind to, but smaller than, the ballista, which it doubtless suggested. It was used by the Normans at the battle of Hastings. The *arbalest* was a form of it.

Cross-chap Vise. A vise in which the jaws close towards each other in a line contrary to their usual direction.

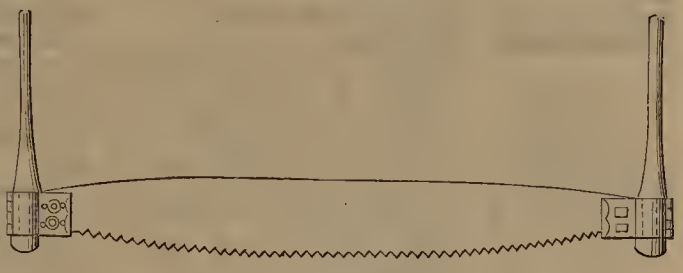
Cross-chock. (*Shipbuilding.*) A piece fayed across the dead-wood amidships, to make good the deficiencies of the lower futtocks.

Cross-course. (*Mining.*) A non-metalliferous seam crossing at right angles thereto.

Cross-cut. (*Mining.*) A drift from a shaft, to intersect a vein of ore.

Cross-cut Chis'el. A chisel with a narrow edge and considerable depth, used in cutting a groove in iron, especially in cast-iron, where a portion is to be cut or broken off.

Fig. 1521.

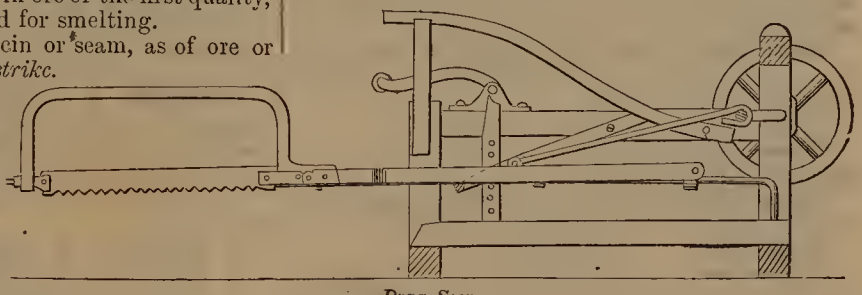


Cross-Cut Saw.

Cross-cut Saw. A saw adapted for cutting timber across the grain.

Hand-saws are made and set for the purpose. The ordinary saw for cutting timber into lengths has a handle at each end and cuts each way.

Fig. 1522.



Drag-Saw.

The *drag-saw* is for cross-cutting, but only cuts on the *pull* motion, being stocked at one end.

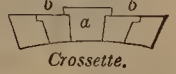
Crossed Belt. (*Machinery.*) A belt crossed between pulleys so as to revolve them in opposite directions. (See BELTING.) To prevent the rubbing of the belts, rollers may be interposed.

Crossed Lens. (*Optics.*) A form of single convex lens having the least spherical aberration. The refractive index of the glass should be 1.5, and the radius of the posterior surface six times that of the anterior surface, both surfaces being convex.

Crossed Out. When the web of a wheel is sawed and filed away so as to leave a cross of four spokes or arms, it is said to be crossed out. This is common in watch and clock wheels.

Cros-sette'. (*Building.*) A projecting piece on a *voussoir*, as *a b b*, which gives it a bearing upon the next *voussoir* on the side towards the *springing*.

Fig. 1523.



Crossette.

Cross-file. A file used in dressing out the arms or crosses of fine wheels. It has two convex faces of different curvatures. It is also known as a *double half-round* file.

Cross-frog. An arrangement of crossing rails at a rectangular intersection of roads. Each track is notched for the passage of the flanges of the wheels traversing the other track. A *crossing*.

Cross-gar'net. A cross-shaped hinge made like the letter T on its side (⊢). The cross-portion is fastened to the jamb or post, and the strap is hinged to the vertical leaf and secured to the door or gate.

This is an ancient form, and many very elaborate examples are found in ecclesiastical and feudal architecture.

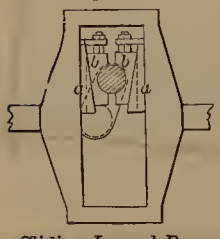
Cross Half-lat'tice I'ron. A kind of angle-iron with four radiating flanges. Double-T iron, with a section like a Greek cross.

Cross-han'dle. A handle attached transversely

to the axis of the tool, as that of the auger. One form of dueling-pistols had a cross-handle.

Cross-head. (*Steam-engine.*) A bar moving between parallel and straight slides. It is driven by the piston-rod, and by means of a connecting-rod imparts motion to a beam, or to the crank of an axle or shaft. On its ends are the *cross-head blocks*, which slide between two parallel guides.

Fig. 1524.



Sliding Journal-Boxes.

The *sliding journal-box* (Fig. 1524) is adapted to occupy a slot in a cross-head to which it imparts motion. The box has two taper-cheeks *a a* and two taper-gibs *b b* adjustable by screws, so as to set up the boxing to the wrist and the cheeks to the guides in the cross-head.

Cross'ing. (*Railway.*) A casting placed at the rectangular intersection of two railways, where the rails of each track are partly cut away to allow passage to the flanges of the crossing wheels.

Cross-jack Yard. (*Nautical.*) *a.* The yard of a square-sail occasionally carried by a cutter in running before the wind.

b. The lower yard on the mizzen-mast.

Cross-lode. (*Mining.*) A cross-vein; one intersecting the principal lode.

Cross-mouth Chis'el. A boring-chisel of a cylindrical form with a diametrical blade.

Cross-pawl. See CROSS-SPALL.

Cross-piece. (*Shipbuilding.*) *a.* A flooring-piece resting upon the *keel* and placed between the *half-floors* which form the lower sections of the *ribs* on each side. The *half-floors* make a butt-joint on the middle line of the vessel between the *keel* and *keelson*.

b. A bar running athwartship between the knight-heads, and to which the running rigging is belayed.

c. A bar connecting the bitt-heads.

Cross-rule Pa'per. Paper ruled off in squares, affording a means of drawing a pattern for weaving or worsted work.

Cross-shed. The upper shed of a gauze-loom.

Cross-sill. A railroad sleeper or tie lying transversely beneath the rails.

Cross-som'er. Or *summer*. A beam of timber.

Cross-spall. (*Shipbuilding.*) A temporary horizontal timber-brace, to hold a frame in position. Vertical or inclined braces are called *shores*.

Cross-spalls hold the position afterwards occupied by the *deck-beams*.

Cross-spring'er. (*Architecture.*) In a groined arch, the rib that springs from a pillar in a diagonal direction at the intersection of the arches forming the groin.

Cross-staff. A surveyor's instrument for measuring off-sets.

Cross-strain'ing. (*Saddlery.*) Canvas or webbing stretched transversely over the first *straining*. The two are stretched over the tree, and united form the foundation for the seat of the saddle.

Cross-tail. (*Steam-engine.*) A bar connecting the rear ends of the *side-bars* of a back-action steam-engine. The side-bars proceed from the cross-head on the end of the piston-rod, and receive motion from the piston; from the cross-tail proceeds the pitman, which is connected to the crank of the propeller-shaft.

Fig. 1525.

Cross-Tail Gudgeon.

Cross-tail Gud'geon. (*Machinery.*) A gudgeon having a winged or ribbed shank.

Cross-tie. (*Railroad Engineering.*) A cross-sill beneath the rails, to support them and keep them from spreading apart.

Cross-tim'ber. (*Shipbuilding.*) One of the *floor-timbers* of a frame, resting at its middle upon the *keel*. Butted against its *heads* are the *heels* of the *first futtocks*. Alongside of it are *half-floor timbers*, whose *heels* butt against each other over the *keel*.

Cross'-trees. (*Nautical.*) Timbers athwartship in the tops, resting on the trestle-trees, to spread the shrouds of the mast above and support the frame of the top.

Cross-vault'ing. (*Architecture.*) A ceiling formed by the intersection of two or more simple vaults of arch-work.

Cross-weav'ing Loom. A loom for weaving with a crossed warp.

Cross-web'bing. (*Saddlery.*) Webbing stretched transversely over the saddle-tree, to strengthen the foundation for the saddle-seat.

Cro'ta-lo. A Turkish musical instrument.

Cro'ta-lum. (*Music.*) An ancient castanet, used in the rites of Cybele.

Crotch. (*Nautical.*) A forked post for supporting a boom or horizontal spar.

Crotch'et. 1. (*Surgical.*) (Fr. *crochet*, a hook.) Applied to surgical and other instruments of a hooked form derived from the French; as the *craniotomy* or *placenta* hooks.

Specifically, a curved instrument for extracting the fetus.

2. (*Printing.*) A bracket ("[ ]").

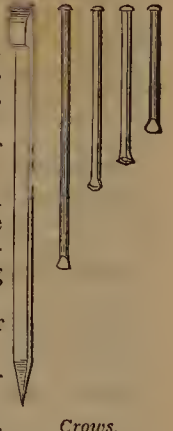
3. (*Nautical.*) A forked support. A *crotch*.

4. (*Fortification.*) An indentation in a covered way, opposite to a traverse.

Croud. A crypt, or under-croft of a church.

Crow. 1. An iron bar used as a lever; it had usually a bent end, which was frequently forked, and may have been named from its fancied resemblance to a beak.

Fig. 1526.



Crows.

2. Formerly, the beak or rostrum on the stem of a war-galley. Also a device formerly used, consisting of a pivoted lever and chain with hooks for engaging an enemy's vessel or picking off her men. A *corvus*.

Crow-foot. 1. (*Nautical.*) A contrivance for suspending the ridge of an awning. It consists of a number of cords depending from a long block called an *euphroe* or *uphroe*.

2. (*Fortification.*) A *crow's-foot* or *caltrop*. See CALTROP.

Crowle. An old English wind-instrument.

Crown 1. (*Architecture.*) *a.* The vertex of an arch.

b. The *corona* or upper member of a cornice.

2. The dome of a furnace.

3. A size of paper, 15 × 19 inches.

4. The hub or canon of a bell.

5. The upper surface of a hat body.

6. An English silver coin; value, 5 shillings.

7. The part of a cut gem above the girdle.

8. The part of an anchor where the arms join the shank.

9. The steel face of an anvil.

Crown-gate. The head-gate of a canal-lock.

Crown-glass. Glass made by blowing and whirling, changing the ball of glass into a globe and eventually into a disk attached to the end of the *ponty*. Window-glass is made in this manner. Crown-glass is a finer variety, a compound of sili-

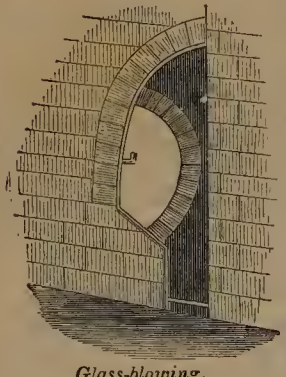
cate of potash, or soda, and silicate of lime, — silica, 63 ; potash, 22 ; lime, 12 ; alumina, 3. It is much harder than the glass into whose composition lead enters, and which is called *flint*-glass.

Bohemian glass, in its composition, is similar to the above in respect to the absence of lead in notable quantities. It is a silicate of potash and lime, with a little silicate of alumina. It is very hard, transparent, and difficult to fuse.

Crown-glass is made in round disks by the following process : —

The materials are fritted in a reverberatory furnace, and then melted in a pot. A lump of glass sufficient to make a *table* of nine pounds weight is extracted at the end of a *blowing-tube*, and is dis-

Fig. 1527.



Glass-blowing.

tended into a pear shape by blowing through the tube and rolling on the *marver*, which is a cast-iron slab on a stand. Being softened by heat at the mouth of a small blowing-furnace, it is rolled on the *marver* and blown till it assumes a more spherical shape, but has a conical end, which is removed as the glass approximates a spherical form, being blown as it is rolled on the *bullion-bar*. Being again heated at the blowing-furnace, rotation and blowing being persevered in, it becomes spherical. It is then presented at a larger furnace-hole called the *bottoming-hole*, and being rapidly rotated becomes oblate. A *pontil* tipped with molten glass is then applied to the center of the flat portion, and the blowing-tube is detached by touching the neck of the globe with a cold wet iron. This leaves a hole in the end from which the blowing-tube was detached, and the article appears as shown at the right-hand upper corner.

Heat and rotation being still applied, first at a furnace-opening of moderate size called the *nose-hole*, and then at a much larger one called a FLASHING-FURNACE (which see), the hole becomes more and more enlarged as the article becomes more and more oblate. Finally it flies open with a sharp rustling noise, and appears as a flat plate, called a *table*, adhering at its central, thicker portion, the *bull's-eye*, to the *pontil*, by which, during the later portions of the process, it was rested on the hook in the half-wall before the furnace, which formed a partial screen for the workman.

When it has cooled sufficiently to be rigid and not liable to bend or collapse, it is placed on a fork, the *pontil* detached by the application of a cold iron, and the *table* placed in the annealing arch or kiln, where it rests on its edge for perhaps twenty-four hours, gradually cooling. The annealing-arch is termed a *leer*, and this is often made continuous ; the trays holding the ware traveling from the hot to the cool end, being pushed along as the trays of recently made glass-ware are received at one end, while the contents of the trays at the discharge-end, having cooled sufficiently to bear handling, are removed.

The size of a *table* or disk of crown-glass is about 52 inches, and a pot holding one half-ton will make about 100 tables.

Crown'ing. 1. (*Machinery.*) The central bulge or swell of a band-pulley.

2. Convex at top ; opposed to *dishing*.

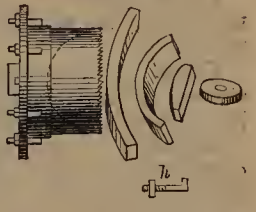
Crown-pa'per. Paper which formerly had the crown for a water-mark. Its size is 15 × 19 inches.

Crown-piece. A strap in a bridle, head-stall, or halter, which passes over the head of a horse, its ends being buckled to the cheek-straps.

Crown-post. (*Carpentry.*) A vertical post in a truss, supporting the crown-plate in a *king-post truss*. A *king-post*.

Crown-saw. A saw of cylindrical shape, with teeth on the end and operated by a rotative motion. The *trephine* was the first of the class. It is used for making buttons and markers, sawing staves, brush-backs, chair-backs, etc.

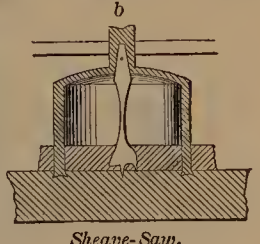
Fig. 1528.



Crown-Saw.

Crown-saws of large size are made in sections, riveted to the outside of a strong ring, and carefully hammered, so that the plates constitute one continuous cylinder ; the edges of the plates making butt-joints with each other. The ring is fixed to the surface-chuck of a lathe-mandrel, by means of hook-bolts *h*, and the work is grasped in a slide-rest, which traverses within the saw and parallel with its axis.

Fig. 1529.



Sheave-Saw.

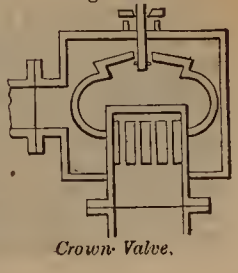
Smaller cylindrical saws are made of a single, bent steel plate, rolled to form, and brazed at the joint. They are used in barrel-making machines, to saw staves from the bolt.

Fig. 1529 shows a crown-saw and bit by which the sheaves for blocks are cut out and bored simultaneously ; *b* is the stock to which the cylindrical saw and the center-bit are attached.

Crown-sheet. The upper plate of a locomotive fire-box.

Crown-tile. A common, flat tile. A *plane-tile*.

Fig. 1530.



Crown Valve.

Crown-valve. A dome-shaped valve which is vertically reciprocated over a slotted box.

Crown-wheel. One in which the cogs are perpendicular to the plane of motion of the wheel. It is also called a *contrate* or *face* wheel. *Contrate* is a term applied to this

wheel in horology. *Face*-wheel indicates that the teeth project from the circular face, as distinguished from the periphery or rim.

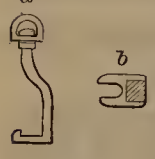
Crown-wheel Es-cape'ment. One so named because the escape-wheel is a crown ratchet-wheel whose teeth escape from the pallets of the verge. A *vertical escapement*.

Crown-work. (*Fortification.*) An extension of the main work consisting of a *bastion* between two *curtains*, which are terminated by *half-bastions* and commanded by the main-work.

Crow's-bill. (*Surgical.*) A bullet forceps.

Crow's-foot. 1. (*Well-boring.*) A bent hook adapted to engage the shoulder or collar on a drill-rod or well-tube while lowering it into a well or drilled shaft, or to hold the same while a section above it is being attached or detached (*a*, *b*, Fig. 1531).

Fig. 1531.



Crow's-Foot.

In well-boring the auger or drill-rod passes through a hole in the staging, but the crow's-foot is too large to pass through the hole, and is thus the means of holding the sections of rod or tubing which are suspended therefrom.

A *scotch* answers the same purpose. It is a bent bar which slips on the rod and forms a resting-place for the shoulder or collar.

2. (*Fortification.*) A ball armed with spikes, so arranged that one is always presented upwardly; such are strewn on the ground for defence against the approach of cavalry. A *caltrop*.

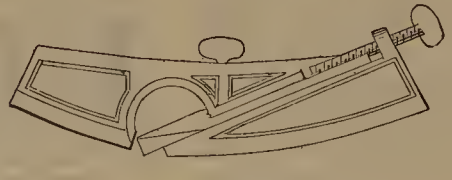
Crow's-nest. A tub or box at the top-gallant mast-head, for the lookout-man who watches for whales.

Croy. A mound or structure projecting into a stream, to break the force of the water on a particular part and prevent encroachments.

Croze. 1. (*Coopering.*) A tool used for making the grooves for the heads of casks, after the ends of the staves have been leveled by a tool called a *sun-plane*, which is like a *jack-plane*, but of a circular plan.

The *croze* resembles a *gage*, except that it is very much larger; the head is nearly semicircular, and terminates in two handles. The stem, which is proportionally large, is secured by a wedge; the cutter is composed of three or four saw-teeth, closely fol-

Fig. 1532.



Cooper's Croze.

lowed by a hooked router, which sweeps out the bottom of the groove.

In another form, it is a circular plane with a gouge-bit.

2. (*Hat-making.*) To unroll and re-roll a hat-body so as to change the surfaces in contact, and prevent their felting together in the process of felting hats.

Croz'ing-ma-chine'. (*Coopering.*) A machine for cutting on staves the croze or groove for the reception of the edge of the head.

Cru'ci-ble. 1. A melting-pot of an earthen composition or of refractory metal, adapted to withstand high temperatures. They are mentioned by the Greek authors, and are shown in the ancient Egyptian paintings, and were early used in docimastic operations, and were made by the old alchemists for their own use. Metallic crucibles are of platinum, silver, or iron. See Faraday's "Chemical Manipulations."

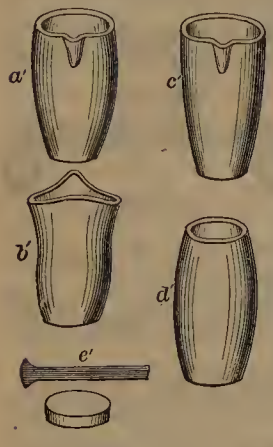
Agricola, the celebrated metallurgist, and Glauber, a noted chemist, both in the sixteenth century, made their own crucibles.

Hessian crucibles are made of the best fire-clay and coarse sand. They are the cheapest, and answer for all uses where a single melting will suffice, as in refining or experiments. They come in nests of sizes from two inches up to eight inches high. They are used in this country in all experiments where fluxes are needed; are round at the bottom, but are furnished both round and triangular at the top. Wedgwood made crucibles in his time of a close and fine texture, but liable to crack. In France an excellent crucible is made at Picardy of a sort of kaolin and fine sand. They are made very thin, turned up on a potter's wheel; are tall and slim, bend easily at a high heat, and are liable to crack in cooling, but are used largely by the melters of bronze and brass in Paris. The Dutch made what were known as "blue pots," or "black-lead pots" of clay and graphite in the early part of the seventeenth century; and in their day these were the safest melting-pots, because they would stand four or five meltings, and submit to considerable change of temperature, before cracking. The graphite was known by them as *pot loot*, or potter's lead, from the use of it. In England many kinds of clay were used; but the chief dependence was on that known as the "Stourbridge clay," which, when mixed with pulverized coke, made a useful and cheap melting-pot, but it could not be cooled off and used again. In 1827 the late Mr. Joseph Dixon began the manufacture of crucibles by mixing the graphite, otherwise known as plumbago, found in the State of New Hampshire, with a clay used by the glass-makers, for melting-pots; and these were much better than the Dutch pots, being able to stand very great and sudden changes of temperature. Mr. Dixon saw beautiful specimens of foliated graphite, brought home as curiosities by the captains of India ships that had touched at Ceylon; and, finding this better than the New Hampshire graphite, he procured a shipment in 1828, being the first lot of Ceylon graphite ever brought to the United States, and the first known use of foliated graphite for crucible making. About 1830 Mr. Dixon adopted the "Dutch pipe-clay" to mix with the Ceylon graphite. To ten pounds of ground graphite, seven pounds of clay, two pounds of fine kaolin, and one pound of fine quartz sand, add water, to make the mass plastic enough to be turned up on a potter's wheel to the desired shape. To the above, for steel melting, there should be added half a pound of pulverized charcoal or coke, as may be most convenient. The pots are dried carefully, burned in a potter's kiln to a white heat, and are then fit for use. In use, crucibles should be placed in the fire, and not on it. The fire should surround the crucible to the very top, and a blast, if used, should not strike the crucibles direct. They should be kept in a dry place, the least dampness being fatal. If they are well made, no annealing is needed, the object of annealing being only to complete the shrinkage that should be fully accomplished in the "burning" by the crucible-maker. For melting brass, copper, gold, silver, or alloys of metals, a Dixon graphite crucible should run from twenty to forty meltings, according to the fuel, draft, care, or other circumstances. For melting steel they will run from four to six times, and longer by a

systematic cleaning the slag from the surface after each melting, and coating the crucible with a mixture consisting of fire-clay, graphite, charcoal, and pure fine quartz sand. In handling crucibles the tongs should fit so as not to bend them in lifting from the fire, as the frequent bending will crack the crucibles before they are worn out.

Crucibles are made at the Dixon Works, Jersey City, New Jersey, of all sizes, from those that hold but two ounces up to six hundred pounds capacity. Covers are made for all sizes. Retorts of all shapes and chemical ware are also made of the crucible mixture. It will stand a very high heat, but is wasted by most fluxes. At the mints large crucibles are used, and *dippers* are made of the same material, with which the metal is ladled out. *Stirrers* are also made with which to stir up the liquid metal.

Fig. 1533.



Crucibles.

The crucibles are sized by figures denoting the number of kilogrammes of brass they will hold, No. 1 holding 2½ pounds, No. 10 holding 22 pounds, and so on up to No. 300. See GRAPHITE.

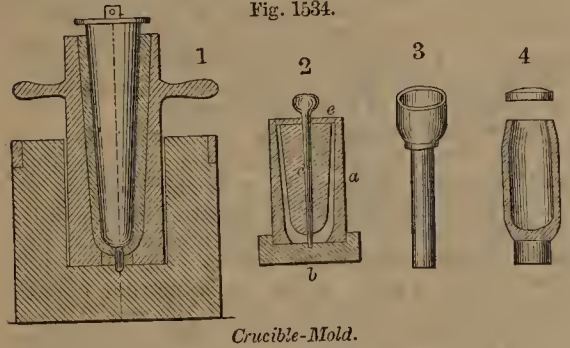
Crucibles for glass-makers are made of a mixture of burned fire-clay very coarsely ground, with the raw clay and a portion of the old pots ground up.

Several forms of melting-pots are shown in Fig. 1533. *a'* and *b'* are refiners' pots for gold and silver; *c'*, a foundry-pot; *d*, a steel pot; *e'*, crucible lid and stirrer of the same intractable material.

2. A basin at the bottom of a furnace to collect the molten metal.

Cru'ci-ble-mold. Crucibles are molded on a wheel or in a press. Different materials, qualities, and sizes require different treatment. One common ordinary mode of forming crucibles for melting steel, in the process of making, is shown in Fig. 1534, 1

Fig. 1534.

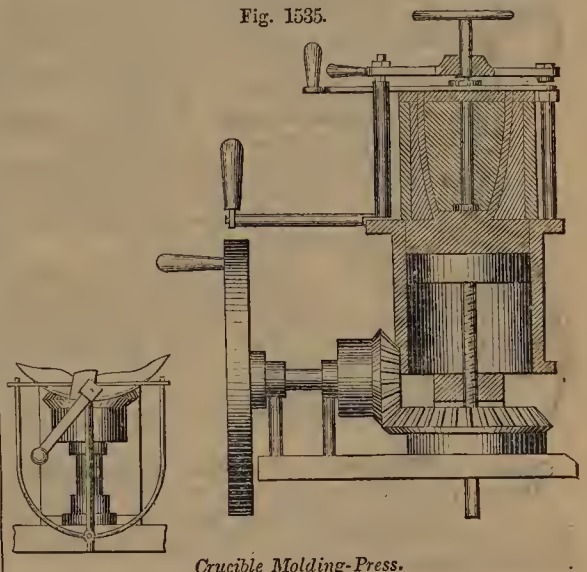


Crucible-Mold.

and 2, which show the cast-iron mold with a hard-wood core; the larger illustration shows a mold with handles for lifting. The lump of clay is placed in the mold *a*, the core *e* is forced down upon it, and driven down by a hammer until the rod in the center enters the hole in the bottom *b* of the mold. *c* is the circular plate which molds the upper edge. In removing, the core *c* is first carefully lifted and the hole in the bottom closed by a plug of clay. The mold *a* is then lifted from the bottom *b* and placed on the post shown at 3; the top of this is somewhat smaller than the opening in the bottom of the mold, which is then pressed carefully downward, leaving the molded crucible on the top of the post. The upper margin of the crucible is then pressed in by hand, assuming the form represented at 4; the circular cover and cylindrical stand-piece being also shown.

Fig. 1535 shows a form of press for molding crucibles, in which the piston forces the clay from the

Fig. 1535.

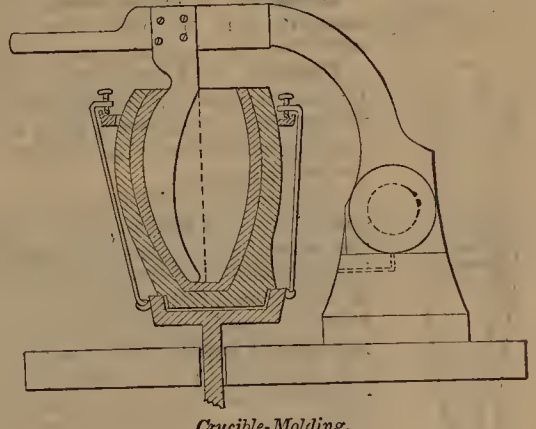


Crucible Molding-Press.

cylinder into the mold above. The bottom of the mold corresponds to the base of the crucible, and the core is held in place by a locking-plate above. The clay in the mold is cut off from the mass by a wire which runs between the cylinder and the mold.

In the molding of crucibles on a throwing-table the latter has a rim-base for the mold, and is rotated by power applied beneath. The plaster-of-paris mold has a detachable bottom, and its circular body is divisible vertically into two halves secured by a hoop. The mass of material, being placed in the

Fig. 1536.



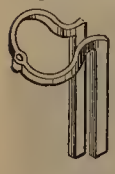
Crucible-Molding.

mold, is fashioned by a hinged molding-blade, which corresponds in shape to the inner surface of the intended crucible, and by pressure builds up the plastic material against the inside surface of the mold. The surplus material at top is cut off with a knife. The blade is withdrawn, and the crucible, with its mold, is removed to dry and harden, previous to burning.

One other mode of molding is sometimes practiced:

the slip, of the consistence of cream, is poured into molds made of stucco, and allowed to stand in the mold until a sufficient quantity will adhere to the mold, when the remaining liquid portion is poured out. The mold and its inner coating of *slip* are removed to the oven, when the slip contracts and may be removed. When dry, the biscuit crucible is ready for baking.

Fig. 1537.



Cru'ci-ble-ov'en. A heater for crucibles, to dry them before burning in a kiln. Plastic clay is molded into *green* crucibles, assumes the *biscuit* form by drying, and is *burned* to constitute a crucible.

Cru'ci-ble-tongs. A form of tongs for lifting crucibles from the furnace.

Crucible-Tongs.

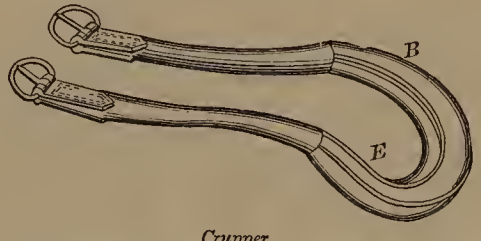
Cru'et. A jar or bottle for condiments or flavors used at table upon meats, etc. A *caster*. A *cruet-stand* holds a number of such little vials.

Cruive. A salmon-trap of the nature of a weir. It has stone walls, which cross the river, and an intermediate chamber of slats or spars which admit the fish but oppose their exit.

Crumb-re-mov'er. A tray for receiving the crumbs swept up by the crumb-brush.

Crup'per. (*Harness.*) A loop which passes beneath the tail of a horse, and is connected by a strap with the saddle, to keep it from riding forward. The rounded portion *E B* is the *crupper-loop*.

Fig. 1533.



Crupper.

Crup'per-chain. (*Nautical.*) A chain for lashing the jib-boom down to the bowsprit.

Fig. 1539.

Crutch.

Crush'er. A mill or machine for mashing rock or ore. See ORE-CRUSHER; STONE-CRUSHER; STAMP.

Crutch. 1. A staff with a cross-piece to support the person beneath the arm-pit. The foot is shod with a rubber pad, or may have a spur to prevent slipping.

2. (*Horology.*) The fork at the end of the arm which depends from the axis of the anchor-escapement. The pendulum-rod is contained within the limbs of the *crutch*, and vibrates the anchor, itself also receiving a slight impulse from the train.

3. (*Saddlery.*) One form of pommel for a lady's saddle, consisting of a forked rest which holds the leg of the rider.

4. (*Shipwrighting.*) *a.* One of the struts or stay-plates in the prow or stern of an iron vessel, which supports the sides where they nearly approach each other. They occupy a position corresponding to that of the *dead-wood* in a timber vessel, and are used to prevent the crushing in of the plating.

b. A knee-timber placed inside a vessel to secure the heels of the cant-timbers abaft.

c. A support upon the taffrail for the boom.

d. A forked row-lock upon the gunwale.

5. (*Founding.*) The cross-handle on the end of a *shank*, (a founder's metal-ladle,) by which it is tipped.

Crwth. A Welsh musical instrument with six strings, played upon with a bow.

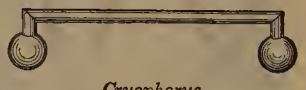
The first four strings are conducted from the tail-piece down the finger-board; but the fifth and sixth, which are about an inch longer than the others, branch from them laterally, and range about the distance of an inch from the neck.

Cry'o-lite-glass. A semi-transparent glass made from cryolite and sand, and sometimes known as *fusible porcelain* or *milk-glass*.

Cry-oph'o-rus. An instrument to illustrate the process of freezing by evaporation. Invented by Dr. Wollaston.

It consists of two bulbs and a connecting tube, air being expelled from the interior by heating the body of water inclosed and hermetically closing the opening. The water being poured into one bulb, the other bulb is placed in a mixture of ice and salt, which condenses the vapor and causes so rapid evaporation from the former bulb as to freeze the water therein.

Fig. 1540.



Cryophorus.

Crypt. (*Masonry.*) A vault beneath a church or mausoleum, and either entirely or partly underground.

Cryp'to-graph. A message written in cipher.

Crys'tal. (*Glass.*) A peculiarly pellucid kind of glass.

Crys'tal-lized Tin-plate. Or *moire-métallique*. A variegated crystallized appearance produced on the surface of tin-plate by applying to it in a heated state some dilute nitro-muriatic acid, washing it, drying, and coating it with lacquer.

Crys-tal'lo-ce-ram'ic. A kind of glass incrustation. It consists of an opaque substance, imbedded in a mass of colorless glass. A medallion or bas-relief is molded in a peculiar kind of clay, and inclosed between two pieces of soft glass in their melted state. The molten glass is dropped upon the surface of the medallion, and the surface afterwards polished. The white clay seen within the clean and highly refractive glass presents an appearance nearly resembling that of unburnished silver.

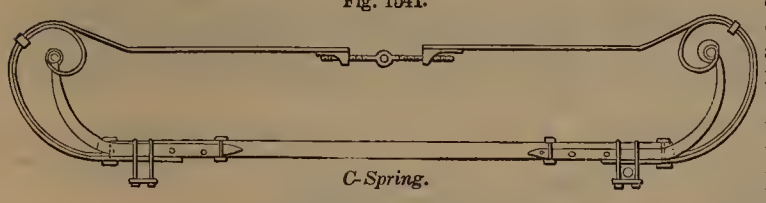
Crys-tal'lo-en-grav'ing. A mode of ornamenting glass-ware by taking impressions from intaglio, and impressing them on the ware while casting.

The die is first sprinkled over with Tripoli powder, then with fine dry plaster and brick-dust, and then with coarse powder of the same two materials; it is placed under a press, and at the same time exposed to the action of water, by which the sandy layers become solidified into a cast. This cast thus obtained is placed in the iron mold in which the glass vessel is to be made, and becomes an integral part of the vessel so produced; but by the application of a little water the cast is separated, and leaves an intaglio impression upon the glass as sharp as the original die. The cake thus used seldom suffices for a second impression.

Crys-tal'lo-type. A photographic picture on glass.

C-spring. (*Vehicles.*) A spring, in form like the letter C, and employed in close carriages of old style, and some modern ones. It is planted on the frame of the carriage, and to its upper pliable end the suspension-straps are fastened.

Fig. 1541.



C-Spring.

Cube Su'gar-ma-chine'. A machine for cutting up loaf-sugar into little cubes for table use consists of a set of circular saws which reduce it to the form of long square sticks. These are dropped into upright grooves in the machine, of which there are a number side by side, and of which the bottoms are removable plates. These form stops, and at the regulated distance above are a pair of knife-edges which move inward toward each other and divide all the columns of sugar simultaneously. As the knife-edges close, the supporting-plates open and allow the cubes to drop.

Cuck'oo-clock. One in which the hours are sounded by wind proceeding through reeds which simulate the voice of the bird after which it is named.

Cuck'old's-neck. A knot by which a rope is secured to a spar, the two parts of the rope crossing each other and seized together.

Cu-cur'bit. An earthen or glass vessel used in distillation, and having a rounded shape like a gourd; hence the name. It contains the liquid to be distilled, and is crowned by the *alembic*. See ALEMBIC.

Cu'cur-bit'u-la. A cupping-glass.

The *cucurbitula cruenta* is designed to draw blood.

The *cucurbitula sicca* is for dry cupping, and is a local vacuum-apparatus.

The *cucurbitula cum ferro* is armed with iron.

Cud'dy. 1. (*Nautical.*) *a.* The cook-house or galley of a vessel.

b. A small double-decked portion of a canal-boat or lighter, forming a cabin for the crew.

2. A lever mounted on a tripod for lifting stones, leveling up railroad-ties, etc. A *lever-jack*.

Cue. A staff with whose end the billiard ball is struck. It is usually shod with vulcanite or leather. This end is known as the *tip*.

Cui-rass'. An armor for the body; formerly of leather, but now of metal. It consists of a breast and a back plate, lapping on the shoulders and buckled together beneath the arms.

It succeeded the *hauberk*, or coat-of-mail, and the *hacqueton*, or padded leather jacket, about 1350. It has survived all other forms of defensive armor for the body, being yet in use in the heavy cavalry of some European armies.

The *surcoat* or *jupon*, which usually covered the former styles of armor, was laid aside about the time the cuirass was adopted, say the reign of Edward III.

The early cuirass of the Greeks was of linen, which was afterwards covered with plates of horn or scales of horse-hoofs.

The Roxalani wore leather with thin plates of iron. The Persians wore a similar cuirass. The Romans introduced flexible bands of steel, folding over one another during the flexure of the body.

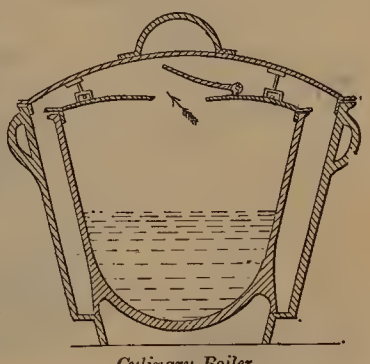
The Roman *hastati* wore chain-mail (*hauberks*). The same nation, as well as the Greeks, used the back and breast plate.

Cuisse. Plate-armor for the thigh. *Cuish; cuissot; cuissart.*

Cu-lasse'. (*Diamond-cutting.*) The lower, faceted portion of a brilliant-cut diamond, which is imbedded in the setting, or is below the girdle. The culasse has twenty-four facets, which occupy the zone between the girdle and the *collet* or *culet*. See BRILLIANT.

Cu'li-na-ry-boil'er. A cooking-vessel for holding water in which victuals are boiled. Its form and appurtenances are adapted to the customary uses of peoples,— to be swung over a fire, stand on a hearth, rest on the bars of a grate, set within a pot-hole of a stove. In Fig. 1542, the kettle is placed in an open-bottomed shell of similar shape, but of size sufficient to allow the caloric current circulation between them. A valve in the kettle-lid allows escape of steam beneath the lid of the shell.

Fig. 1542.

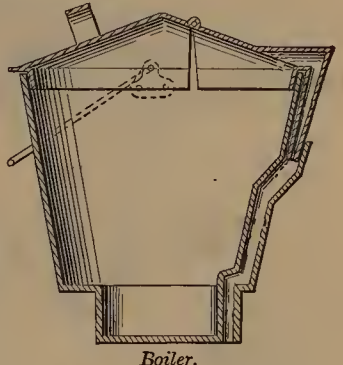


Culinary-Boiler.

Another form has a duct for leading off steam and effluvia. The lid has a hinged portion with a spout which conducts the steam to a pipe which leads it to the fire-chamber.

The boilers of nations unacquainted with metal or pottery were usually plaited vessels of roots or rushes so closely worked as to be water-proof, or treated with some water-resisting substance. The latter varied with different nations and tribes, according to the materials at hand.

Fig. 1543.



Boiler.

Some of the North American Indians made their boilers of long, tough roots wound in plies around a center, and shaped like an inverted beehive. The water in all such vessels was heated by the introduction of hot stones from a fire kindled on the ground in the vicinity.

"If the Scythians do not happen to possess a caldron, they make the animal's paunch hold the flesh, and, pouring in at the same time a little water, lay the bones under and light them. . . . . By this plan your ox is made to boil himself." — HERODOTUS, IV. 61.

The Dacotah Indians sometimes boil animals in their own skins, taking the skin off whole, suspending it at the four corners, and making use of boiling-stones as usual.

The plan was commonly used in the stone age of Europe, and, no doubt, of other regions. The "boiling-stones" are familiar objects with archæologists, and are found with flint tools and weapons.

Several tribes of Polynesia and Oceanica have been discovered entirely destitute of any knowledge of boiling water. It occasioned the most intense wonder. Says Wallis: —

"It is impossible to describe the astonishment expressed by the Society Islanders when they saw

the gunner dress his pork and poultry by boiling them in a pot. Having no vessel that would bear the fire, they had no idea of hot water."

Captain Cook says they had but two modes of cooking, — broiling and baking.

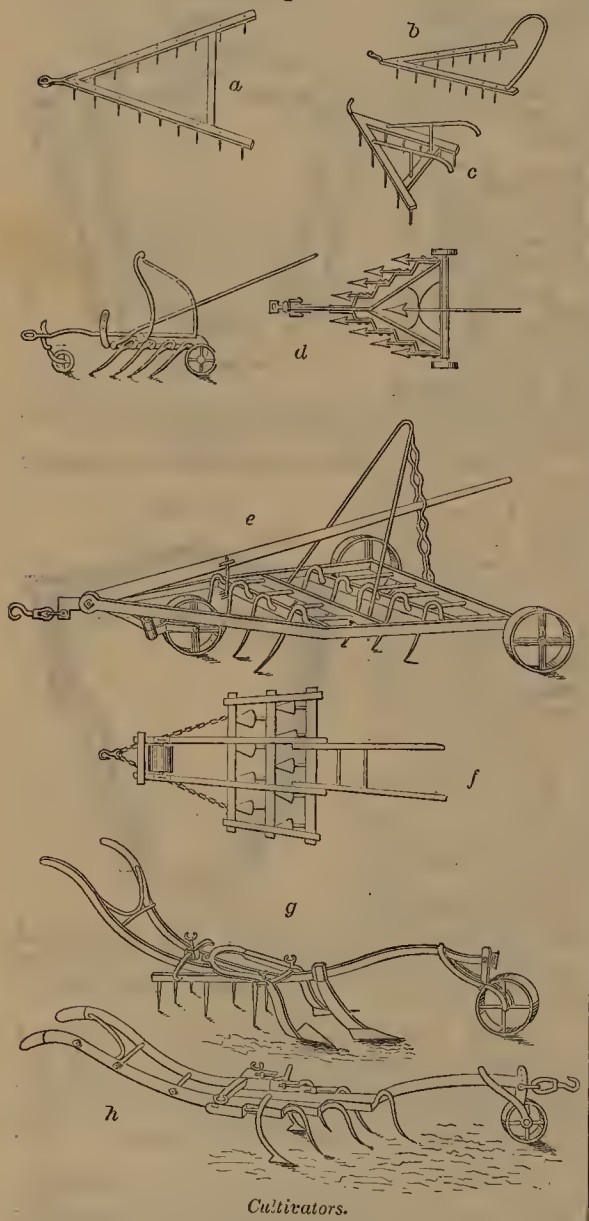
Cul'let. 1. A small central plane in the back of a cut gem.

2. (*Glass.*) Broken glass for remelting.

Cul'lis. A gutter in a roof or elsewhere.

Cul'ti-va'tor. This term, in a broad signification, includes harrows, drags, grubbers, scarifiers,

Fig. 1544.



Cultivators.

scufflers, pulverizers, spiked harrows and rollers, horse-hoes, shovel-plows, and some other implements. The essential idea of cultivation is of course broader still, as it comprehends all the means of tillage, which would include plows, the dominant implement in the art of husbandry.

The term *cultivator*, in the United States, embraces implements which are used in tending growing crops. These are: —

1. The implement specifically known as a *cultivator*, having a triangular frame set with teeth or shares, and drawn by one horse, which walks in the balk between the rows of corn, potatoes, or other plants. The animal is hitched to the apex of the frame, and the implement is guided by a pair of handles at the rear.

2. *Single* and *double shovel-plows*, which are used for precisely the same purpose, but are known as plows. See SHOVEL-PLOW.

The cultivator is an improved harrow.

The course of improvement is not difficult for a farming mechanic to imagine.

The ordinary harrow, we may say, is dependent for its course solely upon the direction of draft.

A good harrow, especially for new ground and in fields where there are occasional obstructions, is that of an **A** form (*a*, Fig. 1544). The rear corners may be readily raised by a hooked stick, so as to allow it to pass a stump without swerving the team. Better still is a bow of hickory, as in the next figure (*b*); by this it may be lifted one side at once, or, by swinging back on it, the whole harrow is lifted, to clear it of accumulated weeds, etc. This harrow is for regular service in putting in crops.

A smaller size, with a bow handle, is made to go between two rows of corn, potatoes, beans, etc., the handle affording the means of swaying it towards or from the row, to suit any irregularity in the line of plants, and also to keep it to its duty if the horse swerves from the exact path.

Another mode of affixing handles is shown in the next figure (*c*), and this brings the subject to such close relationship to the cultivator as to render it unnecessary to trace the steps farther.

In connection with the subject we must not forget the author of "Horse-hoeing Husbandry." Jethro Tull introduced his system of drilling crops in 1701, with the object of cultivating the plants by machinery. He published his book 1731. His system rendered the cultivator possible.

The English cultivators and horse-hoes may be classed together, as no line of demarcation exists between them. The horse-hoes are designed to tend *drilled* crops, the prongs or shares passing along the balks between the rows of plants,— wheat, barley, oats, rye, turnips, beans, etc. This renders it necessary that the shares should have the same gage of width as the drills; but this is all that is peculiar about them, and is a question of proportion, not principle.

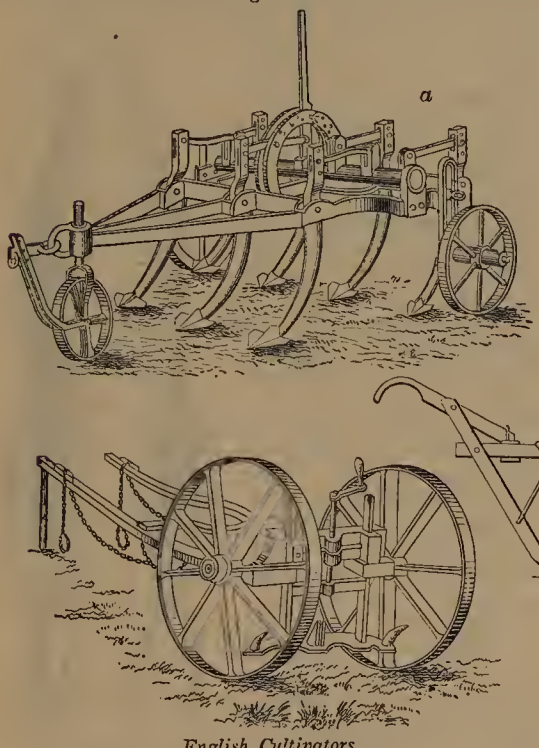
The tendency in all economical farming on an extended scale is toward reducing manual labor. Cultivators and shovel-plows have to a great extent superseded the hoe in corn-culture, and the English *horse-hoe* is designed to do the same in the culture of smaller drilled grain. A man can kill more weeds in a day with a double-shovel plow or cultivator than he can in a week with a hoe, *cæteris paribus*.

Wilkie, of Teddington, Scotland, is the inventor of the cultivator. He invented the plurality of shares, the expanding frame, and the caster-wheel. His cultivator (shown at *d*, Fig. 1544) has a frame of triangular form. The apex is supported on a caster-wheel, and the rear of the frame upon a pair of wheels. The share-frame is so suspended from the traction-frame as by a parallel movement to be raised bodily, or lowered, by means of a single lever projecting at the rear. The lever catches in notches in the segment-bar, so as to maintain the desired adjustment.

The teeth are curved prongs which enter the soil obliquely and raise weeds to the surface; the trash passes up the incline, and falls over the rear ends of the teeth, which are thus self-cleaning.

Finlayson's cultivator *e* (British, 1826) is made of iron, and the prongs are arranged on parallel,

Fig. 1545.



English Cultivators.

transverse bars of the frame, which is supported on a caster-wheel in front and two wheels at the rear. The depth of tilth is regulated by a lever, which is connected to the carriage of the caster-wheel so as to raise the apex of the frame when the lever is depressed, and conversely. The regulation for depth at the rear end is by set screws. The prongs are self-cleaning, having the arched form of Wilkie's; the rear set split the balks left by those preceding.

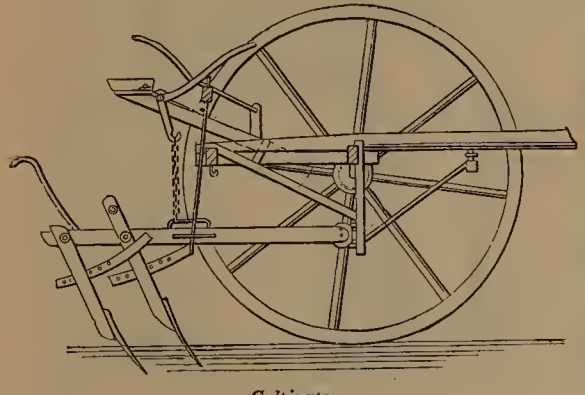
Finlayson's cultivator is shown at *f*.

Wilkie's horse-hoe and drill-harrow *g* (Scotland, 1820) has a central fixed share and adjustable side shares, which are expanded or contracted according to the state of the crop or the width of the balk. Following the shares is a frame with harrow-teeth. Either the share or the harrow-teeth may be removed, and the remainder used separately. The depth is adjusted by the caster-wheel in front.

h shows another form, somewhat modified.

In Fig. 1545, *a* is Colman's cultivator, and that below it is known as a skim-cultivator, with a long,

Fig. 1546.



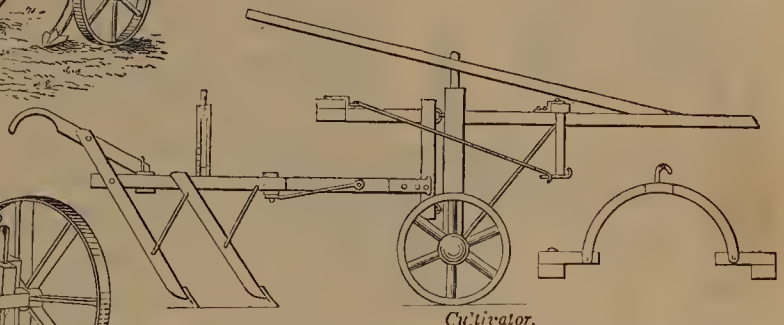
Cultivator

curved, flat share, whose depth is regulated by a crank and screw.

Fig. 1546 shows one American form of cultivator, in which the plows are managed by levers in driving and riding, and by the handles when walking behind the machine. The plow-beams are gimbal-jointed to standards depending from the axle, and have vertical and lateral movement by two hand-levers.

Fig. 1547 shows a form in which the plow-frames are attached by an arched yoke, which permits in-

Fig. 1547.



Cultivator.

dependent motion. Their clevises embrace posts shackled to the carriage.

Cul'ti-va'tor-plow. A plow used in tending crops, such as *shovel-plow*, a *double shovel-plow*, etc. See CULTIVATOR.

Cul'ver-rin. (*Ordnance.*) A cannon of the sixteenth century; from 9 to 12 feet long, 5½ inches bore, and carrying 18-pound round-shot. A demi-culverin was a 9-pounder.

Cannon in those times were named after reptiles and rapacious animals; as, for instance, —

Culverin (*couleuvrine*, Fr.), serpent, from the snake (*coluber*), which was formed upon it to constitute handles.

Musket (*mosquet*, Fr.), sparrow-hawk.

Dragon (Fr.) was the name of a certain form of *musquet*, and survives in the word *dragoon*.

Falcon was an ancient name of a certain grade of ordnance.

Cul'vert. A drain or water-way of masonry beneath a road or canal. It is a bridge or viaduct on a small scale.

Cul'ver-tailed. Dovetailed. (*Culver*, Anglo-Saxon, pigeon.)

Cum'ming. (*Brewing.*) A vessel for holding wort.

Cu-nette'. (*Fortification.*) A small ditch in the middle of a dry ditch, to drain the water off the place.

Fig. 1548.

Cup-Surfaced Boiler.

Cup. 1. The step of the capstan-spindle.

2. A hollowed portion or object, to hold a liquid.

3. A glass placed above a scarified place, to extract blood in cupping.

4. One of a series of little domes (*A*) attached to a boiler-plate and serving to extend the fire-surface. In Fig. 1548 the device is shown as attached to a Cornish-boiler, the cups projecting into the water, and tubes *B* passing through the water-chamber. *C* are pipes connecting the jacket on the interior water-space. *D*, the outer water-space. *E*, passage to admit air to the fire-bridge. *e*, air-induction valve.

Cu'pel. A porous vessel, usually made of pulverized bone-ashes, and employed in assaying for separating the precious metals from their oxydizable alloys. Cupels are made in a mold with a die having a boss-like projection for forming the cavity for containing the specimens to be assayed. Those used in the British mint are made of the cores of ox-horns burned and pulverized.

Fig. 1549.

Cupel-Mold.

Cupels of bone earth are described by the great Arabian chemist Djafar, who lived about A. D. 875. He was the discoverer of nitric acid and aqua-regia. See ALEMBIC.

Cu'pel-la'tion. An alloy of silver and lead is exposed to a red heat on the floor of a muffle, where a current of air plays over its surface. The lead is converted into the protoxide, melts, and runs off, leaving the *refined silver*.

In assaying silver it is purified in a small cupel subjected to an oxydizing heated blast. This leaves it *pure* silver, the lead passing into the porous vessel.

The assay of gold is more complex. The copper and other oxydizable metals are removed by cupellation with lead. A large excess of silver is then added to the alloy, which is rolled into a sheet called a *cornet*. The silver is dissolved out with nitric acid, which leaves the gold as a *sponge*. This is called *parting*.

The process of refining silver with lead in a furnace is described by Ezekiel, and is regarded by Napier as substantially coincident with the modern cupellation.

Cu'pel-lo. A small furnace for assaying.

Cu'pel Py-rom'e-ter. An alloy pyrometer which indicates the heat by incipient or total liquefaction.

Cu'po-la. 1. (*Architecture.*) *a*. A lantern or small apartment on the summit of a dome.

b. A spherical or spheroidal covering to a building or any part of it.

2. (*Metallurgy.*) *a*. A furnace for melting metals for casting. See CUPOLA-FURNACE.

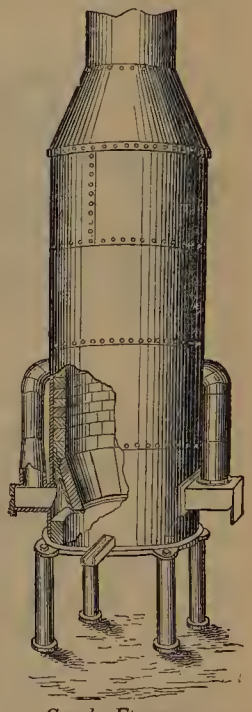
b A furnace for heating shot to be fired at shipping and other inflammable objects.

Cu'po-la-fur'nace. A furnace for melting iron in a foundry.

The name is derived from a cupola or dome leading to the chimney, which is now frequently omitted. A cupola of ordinary size may be thus described: —

At the base is a pedestal of brickwork 20 to 30 inches high, upon which stands a cast-iron cylinder from 30 to 40 inches diameter, and 5 to 8 feet high; this is lined with fire-clay, brick, or other refractory matter, which contracts its internal diameter to from 18 to 24 inches. The furnace is open at the top for the escape of the flame and gases, and for the admission of the charge, consisting of pig-iron, waste or old metal, coke, and lime in due proportion. The lime acts as a flux, and much assists the fusion; chalk or oyster-shells are used where conveniently accessible.

Fig 1550



Cupola-Furnace.

At the back of the furnace are several tuyere-holes, one above another, through which the air is urged by a blower. As the fluid metal collects below, the air is admitted at a higher aperture, and the lower blast-hole is stopped.

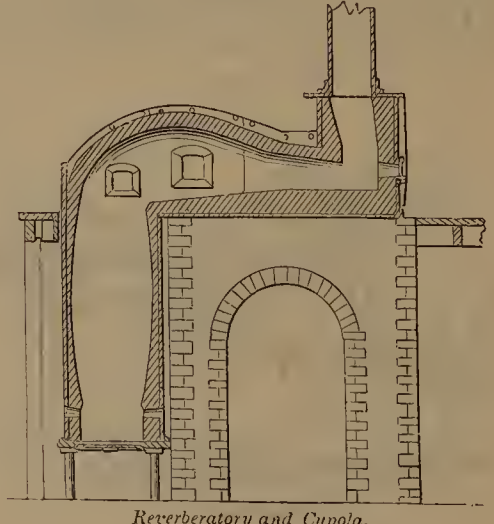
The front of the furnace has a large opening at which clinkers, slag, and unconsumed fuel are removed when cleaning the furnace. This aperture is closed by a *guard-plate*, fixed on by staples attached to the iron case of the furnace. In the center of the *guard-plate* is the *tapping-hole*, which is closed during the melting by a ramming of sand.

Some furnaces are made rectangular or cylindrical, with separate plates like staves, bound by hoops, so that the furnace may be taken down if the charge should accidentally become solidified therein.

Cupolas are built on a scale much exceeding the one just described; the capacity of such may be gathered from the articles CANNON, ANVIL, STATUARY, BELL, etc. A large cupola for anvil-casting is 74 inches in diameter, lined with fire-brick, and having a melting capacity of twelve tons. It has three tuyeres, 9 inches area at the mouth, and situate on three sides of the circle. The holes are in four series. The blast, for this and three other furnaces, is from two revolving fans, 5 feet diameter, and making 1,000 revolutions per minute.

In Fig. 1551 is shown a combination of the reverberatory and smelting-furnace, in which the

Fig 1551.



Reverberatory and Cupola.

charge is first heated on the hearth of the former, and from thence runs or is poled into the cupola. The heat passing from the latter is utilized in the preliminary heating of the charge.

Cupped. (*Machinery.*) Depressed at the center. Dished. The depression around the eye of a millstone is called the *bosom.*

Cup'ping In'stru-ment. The most ancient form of cupping was a sucking action by means of the mouth. Job refers to sucking the poison of asps; from a wound, doubtless. Machaon "sucked forth the blood" from the wounds of Menelaus. Eleanor, the queen, drew the poison from the wounds of her husband, the English king. Tubes were early substituted for the lips, to avoid contact of the purulent matter with the mouth. Blood-letting is still performed by the Hindoos, Chinese, and Malays, by means of a copper cup and tube, the mouth being applied to the latter.

In the late Dr. Abbott's museum of Egyptian Antiquities, New York City, are three of the ancient cupping-horns, similar to those used through the East at the present time. The operator exhausts the air through a small hole at the point of the horn, to which he applies his mouth, and then covers it with a piece of leather, which is attached to it for that purpose. They were found in tombs at Sakkarah.

Cupping-instruments are described by Hippocrates 413 B. C., and by Celsus 20 B. C.

Hero of Alexandria states that the instrument is intended to be used *without fire*, referring to the practice then in vogue of rarefying the air within the tube as a means of obtaining a partial vacuum. The cupping-glass (*A*, Fig. 1552) described by Hero, has an outer chamber with an open mouth *a*, and an inner chamber *b*, divided from the former by a diaphragm *f*; *m* is a valve which governs the opening *e* in the diaphragm; the valve *d* governs the opening *c* by which the chamber *b* is connected with the external air. The valve *d* being opened and the valve *m* closed, the mouth is applied to the opening *c*, and a powerful inspiration is taken, rarefying the air in chamber *b*. This is repeated until the vacuum in *b* is as perfect as can be obtained by means of human inspiration and the muscles of the mouth. The opening of *a* is then applied to the skin of the patient, and the valve *m* being turned "into the void thus created [in *a*] both the flesh and the matter about it will be drawn up through the interstices of the flesh, which we call invisible spaces or pores."

Contrary to common opinion, glass was well known in Egypt 1500 years before Hero.

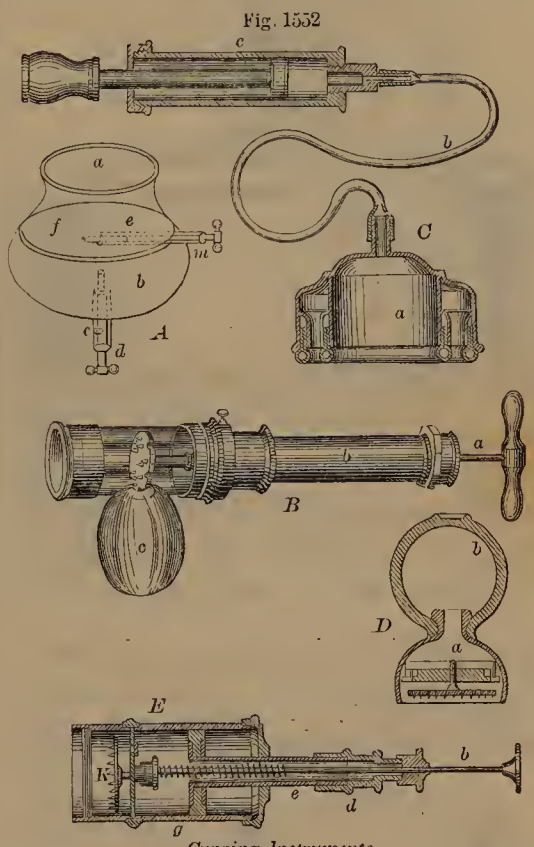
In the cupping-apparatus *B* (Fig. 1552), the glass cylinder has a lip attached suitable for application to the skin, or to the nipple when used as a breast-pump. A central rod *a* has a disk with lancets which act as scarifiers, and the air is exhausted from the cylinder by means of a piston in the tube *b* attached. Detached from the blood-receiver *c*, the air-pump may be used as a syringe.

In the cupping-instrument *C* the receiver *a* is connected by a flexible pipe *b* with the nozzle of an ordinary syringe *c*. The sides of the concentric chamber afford an extended bearing for the cup, and prevent its being driven into the body by the pressure of the atmosphere.

In the instrument *D* the glass has an elastic bulb *b*, by which the partial exhaustion is effected, and has also an adjustable disk provided with puncturing points to lance or irritate the skin.

E (Fig. 1552) is a puncturing and cupping apparatus, in which the scarifier is placed axially within the hollow piston-rod *e*, which works in a stuffing-box on the cylinder *g*. In using, the air is exhausted from *g* by the motion of the piston *e*, operated by the handle *d*. To puncture, the needle-

Fig. 1552



Cupping-Instruments

bar *b* receives a quick downward thrust, forcing the needles on *K* into the protuberant flesh within the cup. The spring returns the needle-bar and disk to position.

Dry cupping is the application of air-exhausted cups to an unscarified place to excite the part, and on an extended scale is known as a DEPURATOR (which see). This was patented in England by N. Smith, 1802. The cup is applied to the patient topically, or an arm or leg may be placed within a suitably shaped chamber, a flexible india-rubber lip adhering to the person and excluding outer air when the air-pump is worked. In the larger form the patient is inclosed in the chamber all but the head, or entirely, as in the AIR-BATH (which see). The action of the skin in each case is excited by the partial removal of external atmospheric pressure.

Cup-valve. (*Steam-engine.*) *a.* A cup-shaped or conical valve, which is guided by a stem to and from its flaring seat.

Fig. 1553.

Cup-Valve.

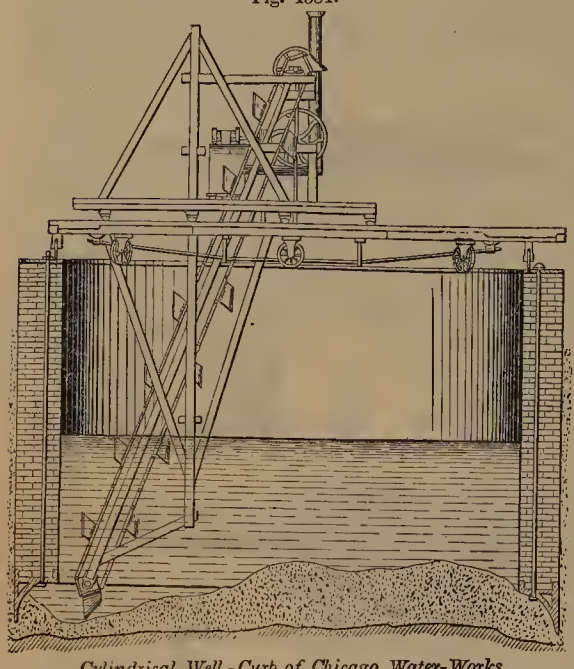
b. A form of balance-valve which opens simultaneously on top and sides.

c. A valve formed by an inverted cup over the end of a pipe or opening.

Curb. A fortified edge or marginal structure, to confine or protect an object, or maintain its shape against external or internal pressure.

1. (*Hydraulic Engineering.*) *a.* A stoned or boarded structure around a well, to keep back the surrounding earth. In Fig. 1554 is shown the curb of the pumping-well of the Chicago Water-Works, which was sunk 29 feet, mostly through quicksand.

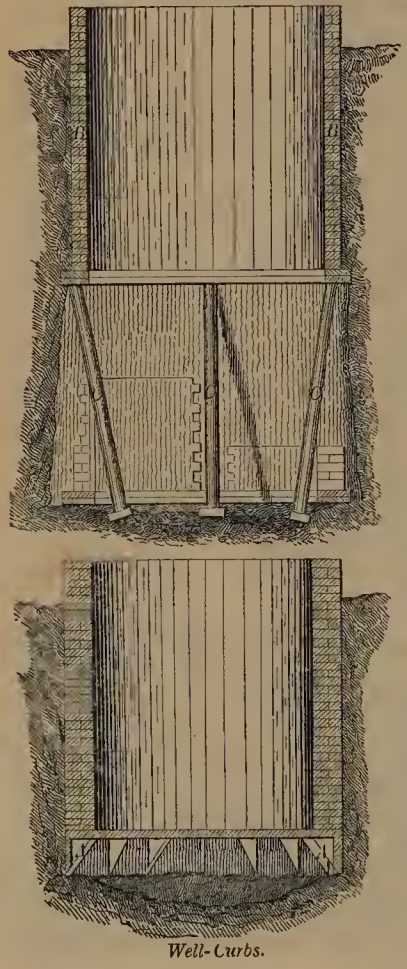
Fig. 1554.



Cylindrical Well-Curb of Chicago Water-Works.

It was 31½ feet internal, 37 feet external, diameter, built of hard brick laid in hydraulic mortar, and plastered inside and out. It was banded every three feet with band-iron, and weighed 440 tons. It was constructed upon a shoe of 32 tons weight, made in eight segments bolted together, and the interior was dredged out without removing the water, to avoid the unsettling of the engine-foundations in the vicinity.

Fig. 1555.



Well-Curbs.

In sinking the curb through dry strata or those in which the water may be removed by pumping, the earth is excavated by digging as the work proceeds, and building up as the structure descends. In sinking wells by sections which are curbed before another section is excavated, the earth is removed from the central part and struts inserted, to hold the upper section while the other is built beneath.

Iron curbs are of boiler-iron or of cast-iron segments bolted together, rings being added at the top as the structure descends. The well at Southampton, England, was some hundreds of feet in depth, and curbed in this way. It was intended to be artesian, but the water did not thus respond.

b. A boarded structure to contain concrete, which hardens and acts as a pier or foundation.

c. The outer casing-wheel of a turbine. It is a cylinder inserted into the floor of the forebay, inclosing the wheel which rotates within.

d. A curved shrouding which confines the water against the floats or buckets of a SCOOP-WHEEL or BREAST-WHEEL (which see).

e. The inclosure which leads water from a forebay to a water-wheel. Also called a *mantle*.

2. A breast-wall or retaining wall to hold up a bank of earth.

3. The edge-stone of a sidewalk, pavement, or trottoir.

4. (*Carpentry.*) *a.* The wall-plate at the springing of a dome.

b. The circular plate at the top of a dome into which the ribs are framed.

c. The wall-plate on the top of the permanent portion of a windmill, on which the cap rotates as the wind veers.

5. An inclined circular plate around the margin of a soap or salt kettle, to return what boils over.

6. (*Harness.*) A chain or strap behind the jaw of a horse, connected at its ends to the rings on the upper ends of the branches of a stiff-bit, and forming a fulcrum for the branches, which act as a lever. See BIT.

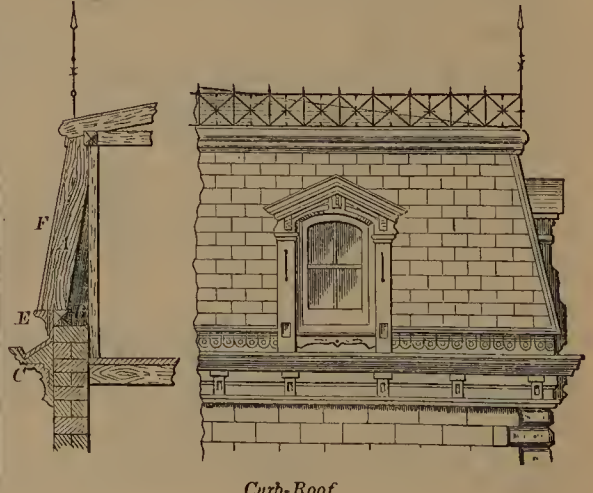
Curb-beam. A beam of a wooden bridge to confine the road material.

Curb-bit. A stiff-bit having *branches* by which a leverage is obtained upon the jaws of a horse. The lower end has rings or loops for the reins, and the upper end has loops for the *curb-chain* and the *cheek-straps* of the head-stall. The curb-chain has usually twisted links, and is fast by one end to the loop of the *off* branch, and is hooked to the loop of the *near* branch. It forms the fulcrum for the leverage of the branches. See BIT.

Curb-pins. (*Horology.*) The pins on the lever of a watch-regulator which embrace the hair-spring of the balance and regulate its vibrations.

Curb-plate. The wall-plate of a circular or elliptical dome or roof.

Fig. 1556.



Curb-Roof.

Curb-roof. (*Building.*) A roof with canted slopes; having two sets of rafters with different inclinations. Otherwise called a *Mansard-roof*, after the French architect who frequently adopted it; or a *gambrel-roof*, from its crooked shape, like the hind leg of a horse.

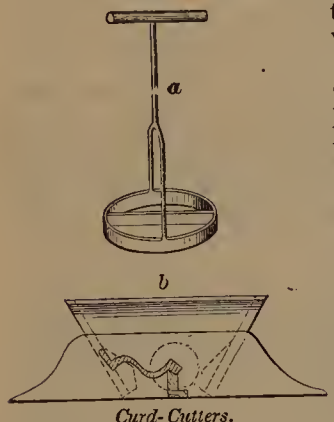
The view on the left represents a section of roof. *A* is the rafter, the foot of which projects over the plate *B*. *C* is the cornice, in which is built the gutter, the metallic lining of which extends nearly to the top of the plate *B*. *E* is a bed-mold covering the ends of the rafters. *F*, slates or shingles running over the edge of the bed-mold *E*. The view on the right shows an elevation of one of these roofs with dormer-window.

Cur-cu'lio Trap. A tray, or a cincture of fiber, attached to the trunk of a plum, apricot, or other curculio-ravaged tree, to intercept the insects which climb up the bark.

Curd-break'er. A frame of wires or slats which is worked to and fro in a vat of cheese-curds, to break the latter into small pieces and enable the whey to drain off. A *curd-cutter*.

Curd-cut'ter. A spindle with revolving knives on an axle, for cutting the curd to expedite the separation of the whey. (*b*, Fig. 1557.)

Fig. 1557.



Curd-Cutters.

Another form of curd-cutter (*a*) is a hoop with a diametric knife having an arched stem and wooden handle. It is used by an up-and-down motion, the curd being in a tub.

Curl'ing-i'ron. A heated rod, or a tube with an internal heater, around which hair is bent and pressed to curl it.

The curling-iron of the Romans was hollow, and named *calamistrum*, from its resemblance to a reed (*calamus*). The use was common among both sexes in the imperial city. It was the duty of the slaves. The same practice, there is no doubt, obtained in Egypt. The ladies of the latter land prided themselves in magnificent coiffures, as we see in the works of Lepsius, Rossellini, Champollion, etc.

The beards of the kings of Nineveh and other kingdoms of the basin of the Euphrates and Tigris were no doubt indebted to the curling iron or tongs; their beards fell in splendid ringlets over the throat and chest.

Curl'ing-tongs. A tongs having one round member and one semi-tubular, between and around which hair is wound to curl it.

Cur'rent. The *fall* or *slope* of a platform or sheet-metal roof, to carry off the water. Gutters usually have a *current* of ¼ inch to the foot.

A flow of water. The direction is the *set* of the current; the rate is the *drift* of the current.

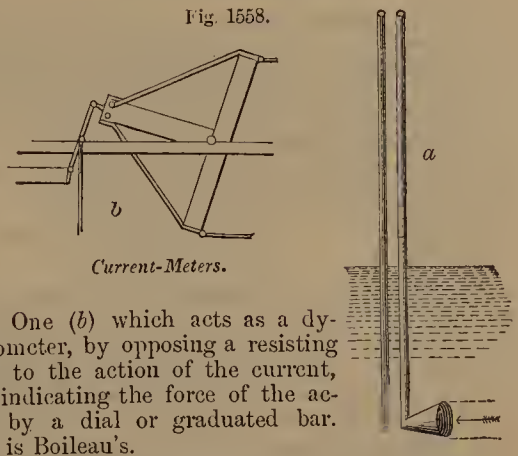
Cur'rent-fend'er. A structure to ward off the current from a bank which it may otherwise undermine.

Cur'rent-gage. See CURRENT-METER.

Cur'rent-me'ter. An instrument for measuring the velocity of currents.

1. The *Pilot tube* (*a*, Fig. 1558), which acts by the ascension of water in a bent pipe whose lower orifice is presented squarely to the current, the indication being read by a float or graduation in or upon the vertical part of the tube.

Fig. 1558.



Current-Meters.

2. One (*b*) which acts as a dynamometer, by opposing a resisting body to the action of the current, and indicating the force of the action by a dial or graduated bar. This is Boileau's.

3. The dynamometer current-gage of Woltmann, 1790, is a light water-wheel operated by the current, and having on its axis an endless screw, which operates toothed wheels and a register, the rate or force being deduced from the rotations in a given time.

The *velocimeter* is a similarly constructed instrument with a converse application, being a spiral wheel attached to a ship and showing by its revolutions the rate of progression of the vessel through the water.

The technical language in which the flow of water and its channels are known and described is as follows: —

Bed; the water-course, having a *bottom* and two *sides* or *shores*. When the latter are described as *right* or *left* hand, going down stream is assumed.

The *transverse section* is a vertical plane at right angles to the course of the current. The *perimeter* is the length of this section in the bed.

The *longitudinal section* or *profile* is a vertical plane in the course of the flowing water.

The *slope* or *declivity* is the mean angle of inclination of the surface of the water to the horizon.

The *fall* is the difference in the hight at any two points of determinate distance apart; as, for instance, 8 inches to the mile.

The *line of current* is the point of maximum velocity.

The *mid-channel* is the deepest part of the bed. The velocity is greater at the surface than the bed. The surface is higher in the current than at the shore when the river is rising, lower than at the shore when the river is falling.

Herodotus (II. 4, 5) reports the Egyptian priests as saying, that in the time of Men [Menes] "all Egypt, except the Thebaic canton, was a marsh, none of the land below Lake Mœris then showing itself above the surface of the water. This is [now] a distance of seven days sail from the sea up the river. What they said of their country seemed to me very reasonable; for any one who sees Egypt, without having heard a word of it before, must perceive, if he have only common powers of observation, that the Egypt to which the Greeks go in their ships is an acquired country, the gift of the river." Wilkinson contradicts the statement, very unreasonably.

In this connection it may be remarked that the alluvial plain at the mouth of the Meander, in Asia Minor, has been advanced toward the sea, in the historic times, a distance of twelve or thirteen miles.

At Ephesus there is now a plain, of three miles width, between the temple and the sea, which has been entirely created since the days of Herodotus.

Ostia, the former port of Rome, is now many miles inland.

Herodotus referred (450 B. C.) to the action of the river Meander, and also stated that "the river Achelous, which, after passing through Acarnania, empties itself into the sea opposite to the islands Echinades, has already joined one half of them to the continent." — Book II. ch. 10.

The volume of water poured during twenty-four hours into the Mediterranean by the Nile is, —

When low . .	150,566,392,368	cubic meters.
When high .	705,514,667,440	" "

The Nile at the first cataract, at Assouan, is 300 feet above its level at Cairo (578 miles), and 365 feet above the Mediterranean (578 + 154 to the Rosetta mouth = 732 miles). The fall from Assouan to Cairo is therefore about 0.54 feet per mile ; from Cairo to the Damietta mouth, about .31 feet per mile. From Assouan to Damietta mouth, an average of 0.524 feet per mile.

The Nile deposit is estimated by Wilkinson, at Elephantine, as equal to nine feet in 1700 years ; at Thebes, seven feet in an equal period.

According to Herodotus, a rise of the Nile equal to 8 cubits overflowed all Egypt below Memphis, in the time of Mœris : "Now Mœris had not been dead 900 years when I heard this of the priests, yet at the present day, unless the river rise 15 or 16 cubits, it does not overflow the land." — HERODOTUS, II. 13. See NILOMETER.

The mean annual discharge of the Mississippi is calculated at 19,500,000,000,000 cubic feet, carrying down 812,500,000,000 pounds of sedimentary matter, equal to one square mile of deposit 241 feet in depth.

The river advances into the Gulf 262 feet per annum.

The fall of the

Lower Mississippi per mile is . .	.32	of a foot.
Ohio per mile is	.43	" "
Missouri below Fort Union per mile is	.95	" "
Upper Mississippi below St. Paul per mile is	.42	" "

Cur'rent-mill. A mill driven by a current-wheel, and usually on board a moored vessel with stream-driven paddles.

The first notice of current-mills is the account of the recourse had to them by Belisarius, A. D. 536, when the Romans were besieged by Vitiges the Ostragoth, who had cut the fourteen aqueducts which brought water to the imperial city. The surplus water of the aqueducts drove the grain-mills of the city, and the recourse had by Belisarius to moored twin-vessels provided with paddles, and the mills, enabled the people to eat bread instead of parched wheat and frumenty.

The German crusaders in the eleventh century burnt seven floating mills on a stream in Bulgaria, — a pretty fair specimen of the crusading rabble.

The current-wheel of Belisarius was patented by Hawkins in England in 1802, and by several other parties before and since, both there and here. See CURRENT-WHEEL.

Cur'rent-reg'u-la'tor. (*Telegraphy.*) A device for determining the intensity of the current allowed to pass a given point. It usually consists of interposed coils of greater or less resistance.

Cur'rent-wheel. The *current-wheel* is perhaps the first application of the force of water in motion to driving machinery. The *noria* has been in use for thousands of years in Egypt, Persia, Arabia, and Syria, and was introduced by the Romans or Saracens (probably the latter) into Spain.

The *noria*, as a water-wheel, has radial floats, which are sufficiently submerged in the current of the river to be acted upon by the water and give rotation to the wheel on its horizontal axis. On the side of the wheel near its periphery are pivoted buckets, which fill as they dip beneath the water, and are tipped, on reaching their highest elevation, by contact with a fixed obstacle, thus discharging their contents consecutively into a chute which conveys it to a reservoir. Hundreds of these wheels are working day and night the year round in the rivers and streams of Syria and Palestine. The *noria* has many modifications which do not come within the denomination of *current-wheel*. The term *Na'Ura* is applied in Syria and Palestine to any device which has pots or buckets attached to a wheel or to a rope passing over a wheel, filled with water at the lowest portion of their revolution, and discharging into a chute at their highest elevation, whether worked by the current or otherwise. See NORIA.

The *tympanum* is another form of *current-wheel*, and like the *noria* has an Eastern origin. It is frequently called the Persian. Unlike the *noria*, it is only capable of lifting water to a height about equal to its radius, while the *noria* lifts water to a height nearly equal to its diameter. See TYMPANUM.

In the first century B. C. water-wheels for driving mills were used in Asia Minor and on the Tiber. In the former case we suppose, and in the latter case we know, that these were *current-wheels*.

Strabo, Vitruvius, Pliny, and Procopius have described them at various times from 70 B. C. to A. D. 555. They were used on the Tiber on a large scale by Belisarius, during the siege of Rome, when the supply by the aqueducts was cut off by the Goth Vitiges, in the reign of Justinian, A. D. 536. See CURRENT-MILL.

The tide and current wheel, erected first in the vicinity of the north end of London Bridge, and subsequently under its northern arch, was erected by Peter Morice, a Dutchman, in 1582, and operated force-pumps which supplied a part of London with water. The stand-pipe from the pump was 120 feet high, and conducted the water to a cistern at that height, where it was distributed to the dwelling-houses in the vicinity, and by four lead-pipes to cisterns at Bishopsgate, Aldgate, the Bridge, and Wall-brook. The amount raised was about 216 gallons per minute. The wheel worked sixteen pumps, each 7 inches in diameter, and having a stroke of 30 inches. Several other similar machines were erected at other points, and were similarly driven.

The axle of the trundle was prolonged at each end, and had quadruple cranks which connected by rods to the ends of four walking-beams 24 feet long, whose other ends worked the piston-rods of the pumps. The axis of oscillation of the lever supporting the wheel, and by which it was adjusted to the state of the tide, was coincident with the axle of the trundle, so that the latter engaged with the 8-feet cog-wheel in any condition of vertical adjustment. Each end of the walking-beam was made effective.

During the seventeenth and eighteenth centuries the works were extended from time to time, and occupied one after another of the arches.

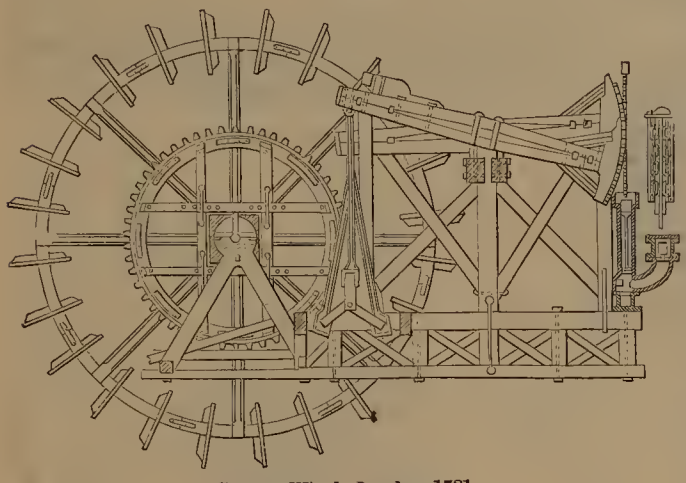
In the first arch of the bridge was one wheel working sixteen force-pumps. In the third arch were three wheels, working fifty-two pumps. The united effect was 2,052 gallons per minute, raised 120 feet high.

In 1767 Smeaton added wheels in the fifth arch. Steam-engines were added about this time to assist at low water and at neap-tides. Thus the matter

remained till 1821. The present daily supply of water to London is equal to a lake of 50 acres, 3 feet deep.

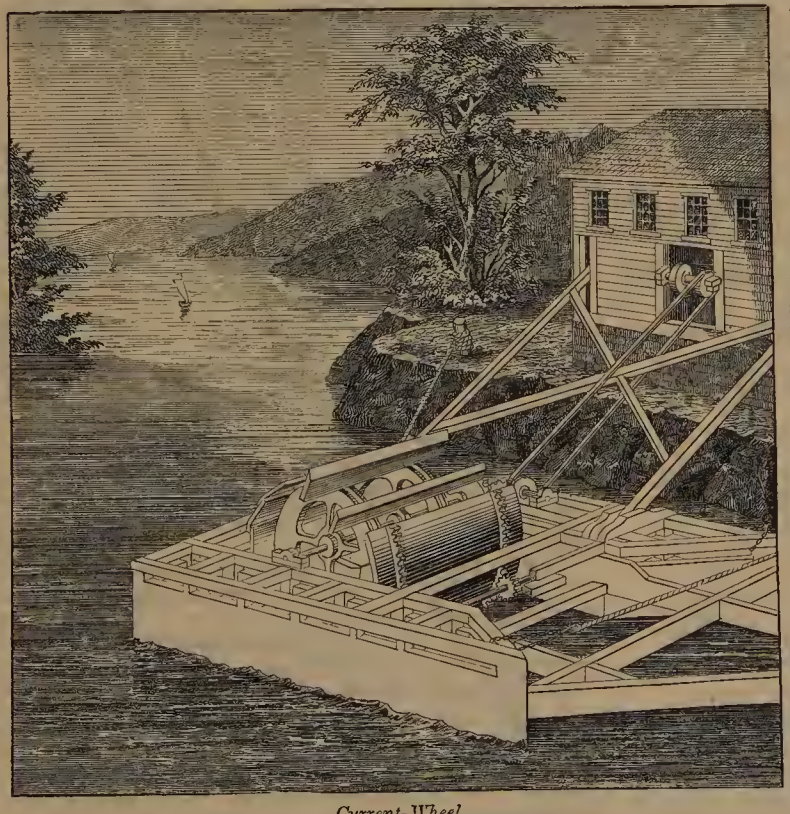
Stow, the antiquarian and historian, describes the works in 1600; and Beighton in 1731 gives an account of them at that date. The water-wheels at that time were placed under several of the arches. The axle of a wheel was 19 feet long, 3 feet diameter. The radial arms supported the rings and twenty-six floats, 14 feet long and 18 inches wide. The axles turned on brass gudgeons supported in counterpoised levers, which permitted the vertical adjustment of the wheel as the tide rose and fell. On the axis of the wheel was a cog-wheel 8 feet in diameter and having forty-four cogs; this meshed into a trundle-wheel 4½ feet in diameter and having 20 rounds, and whose iron axle revolved in brasses.

Fig. 1559.



Current-Wheel, London, 1731.

Fig. 1560.



Current-Wheel.

Fig. 1560 is an illustration of a floating frame in which an *undershot* wheel is journaled; the frame as represented consists of two scows connected by beams and having a skeleton prow to ward off driftwood. The prows of the barges are wedge-shaped, to direct the stream into the space between them occupied by the water-wheel.

A curved gate conforming to the circumference of the wheel regulates the amount of water impinging on the buckets and consequently the speed of the wheel, and also stops the wheel by cutting off the stream from the buckets. The main or wheel-shaft carries on the shore end a bevel-gear that drives a similar gear, from the shaft of which power is carried, by means of pulleys and belts or shafting, to the mill standing upon the bank. The receiving pulley and shaft are hung in a frame, one end of which is hinged or pivoted to the shore-side float or scow, and the other to the mill-building. Thus, whether the water be high or low, the belt is always kept "taut." Chains or ropes moor the floating scows to the shore, and the pivoted frame holds them in position.

Cur'ri-cle. A two-wheel chaise with a pole for a pair of horses.

Curʹrier's Knife. A large, two-handled knife, with a recurved edge, employed by curriers to shave or pare the flesh side of hides.

The knife is about 12 inches long and 5 wide; one end has a plain handle and the other a cross-handle, in the direction of the plane of the blade. The edge of the knife is brought up by means of a whetstone, and a wire edge is constantly preserved by a steel wire which acts as a burnisher.

Fig. 1561.

Currier's Knife.

Curʹri-er's Tools. See:—

Beam.
Beam-knife.
Cleaner.
Clearing-stone.
Crippler.
Currier's knife.
Horse.
Mace.
Pommel.
Raising-board.
Round knife.
Rub-stone.
Slicker.
Steel.
Striking-knife.
Unhairing-knife.

Curʹry-card. A leather or wooden slip with inserted teeth like those of wool-cards, and used for currying animals.

Cur'ry-comb. An implement with projecting serrated ribs, used for grooming horses.

In the sculptures of Nimroud is represented a tent within which a groom is currying a horse.

Cur'ry-ing. The process of shearing the green, tanned skins, to bring them to a thickness, and afterwards dressing them by *daubing*, *graining*, and surface-finishing; transmuting the tanned skins into merchantable leather.

The mechanical part of the process is performed by a peculiar knife (see CURRIER'S KNIFE) upon a nearly vertical *beam* over which the hide is placed.

The mode of currying skins upon a slanting beam or board is shown in the ancient paintings of Kourna, Thebes. *Slicking* with a sharp edge is also shown.

Cur'ry-ing-glove. A heavy glove having a pile of coir woven into a hempen fabric, and shaped to the hand. Back and palm are alike, and either may be used for currying.

Cur'sor. A part of a mathematical instrument which slides on the main portion; as, —

The movable leg of a beam-compass.
The joint of the proportional compasses.
The hand of a barometer.
The beam of the trammel.
The slide of a Gunter rule.
The adjustable plate of a vernier.
The moving wire in a reading microscope.

Cur'tail-step. (*Joinery.*) The bottom step of a stairs, when finished with a scroll and similar to the handrail.

Cur'tain. 1. (*Fortification.*) That portion of a *rampart* which extends between and joins the *flanks* of two *bastions*. See BASTION.

2. (*Locksmithing.*) A shifting plate, which, when the key is withdrawn, interposes so as to screen the inner works from being seen or reached by tools.

3. A strip of leather which overlaps the parting of a trunk.

4. A dependent cloth serving as a screen.

Cur'tain-pa'per. A heavy paper, printed and otherwise ornamented, for window-shades.

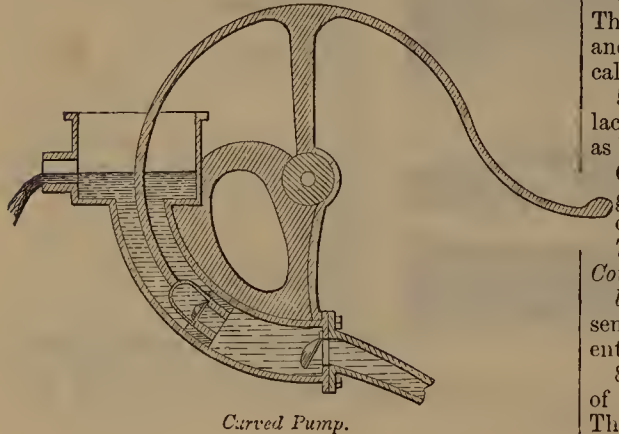
Cur'tal-axe. A short sword with a curved blade. The name has been modified from time to time: *Coutal-hache; coutal-axe; curtle-axe; curtal-axe; coute-lacc; curte-lasse; cutlass.*

Curve. 1. A draftsman's instrument having one or a variety of curves of various characters other than arcs, which may be struck by a compass. Some are constructed for specific purposes, such as *shipwright's curves*, *radii-curves*, etc.

2. A bend in road, canal, or railway; especially in the track of the latter.

Curved Pump. One in which the piston reciprocates in an arc.

Fig. 1562.

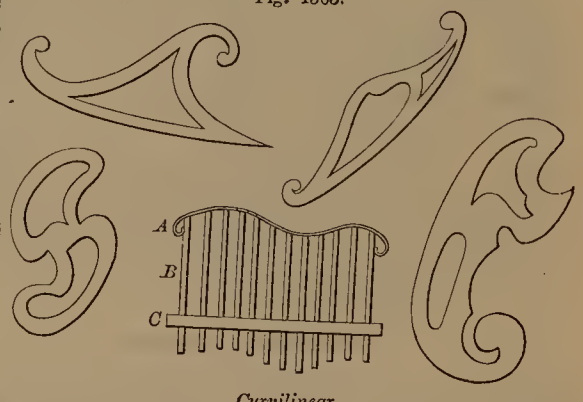


Curved Pump.

Cur'vi-lin'e-ar. A drafting-instrument used in describing irregular curves. The various shapes of its marginal outline enable it to be fitted into position so as to project or transcribe the curve required. M. Desalier, of Paris, invented a machine for generating the curves and marking out the patterns. It is capable of making 1,200 varieties of curves.

The illustration shows one adjustable instrument. The flexible bar *A* is set to any given curve by the adjustment of the ordinal rods *B* in the bar *C*. It

Fig. 1563.



Curvilinear.

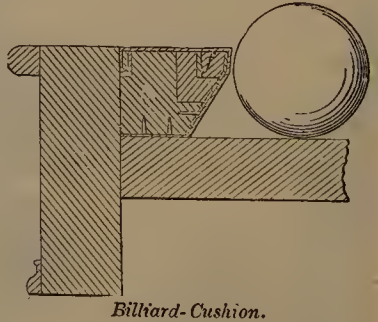
has a greater range of capacity than the *arcograph*, being adapted for double, irregular, and mixed curves.

Curv'o-graph. An instrument for drawing a curve without reference to the center. It is usually an elastic strip, which is adjustable to a given curve, and serves to transfer the latter to another plat or another place on the plat.

Cush'ion. 1. A padded seat, back, or arm of a sofa, lounge, or chair.

An ancient Egyptian cushion, made of linen and stuffed with the feathers of water-fowl, is preserved in the British Museum. See CHAIR.

Fig. 1564.



Billiard-Cushion.

2. The padded edge of a billiard-table, which rebounds the balls.

3. (*Engraving.*) A flat leathern bag filled with pounce and supporting the plate.

4. (*Gilding.*) The pad on which the gilder spreads his gold-leaf, and from which he takes it by a camel's-hair tool called a *tip*.

5. The pillow of the bone-lace maker. Pillow-lace is made by hand, and is of several kinds, known as Valenciennes, Mechlin, Honiton, etc. See LACE.

6. (*Electricity.*) The rubber smeared with amalgam, and whose friction against the glass cylinder or disk causes the electrical excitation.

7. (*Architecture.*) *a.* The impost-stone on a pier. *Coussinet.*

b. A capital of a column so sculptured as to resemble a cushion pressed down by the weight of its entablature.

8. (*Steam-engine.*) A body of steam at the end of a cylinder to receive the impact of the piston. This is accomplished by closing the eduction-port a

little before the end of the stroke, or by opening the induction-port on the same side of the piston, a little before the end of the stroke.

Cush'ion-raft'er. (*Carpentry.*) An auxiliary rafter beneath a principal one, to sustain a great strain.

Cusp. (*Architecture.*) An ornament in stone-work of the Gothic order. It consists of projecting points, formed by the meeting of curves, and is the foundation of the peculiar foliation, feathering, tracery, archery, and panels of the order.

Cut. 1. A term for a certain quantity of yarn.

2. The style of the notches of a file ; as, —

Rough cut.	Smooth cut.
Bastard cut.	Dead-smooth cut.
Second cut.	

3. Cut of a letter ; its size and shape.

4. Cut of a ponton-bridge ; the water-way between the pontons.

Cut-glass. Flint-glass ornamented by cutting away portions.

The decanter, tumbler, or other object, is held against a revolving wheel, whose surface is provided with a grinding material ; and afterwards to another wheel with a polishing powder.

The first, or *cutting*-wheel, is of iron, furnished with sand and water.

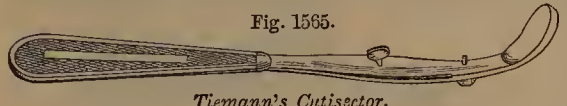
The second, or *smoothing*-wheel, is of stone, with clear water, to work out the scratches of the grinder.

The third, or *polishing*-wheel, is of wood, with rottenstone or putty-powder for polishing.

Cut-in Notes. (*Printing.*) Notes which occupy spaces taken out of the text, whose lines are shortened to give room therefor.

Cu'ti-sec'tor. A knife consisting of a pair of

Fig. 1565.



Tiemann's Cutisector.

parallel blades, adjustable as to relative distance, and used in making thin sections for microscopy.

Cut'lass. Abbreviated from *curtal-axe.* A short, heavy, curving sword ; especially used by seamen in boarding or repelling boarders. Rosalind calls it a *curtle-axe.*

Cut'ler-y. Knives, swords, chisels, and axes were originally made of material found ready to the hand, and this varied with the place. Among the Caribs they were made of shells of the *Strombus gigas,* which is still fished for off the island of Barbadoes. Flint knives and tools were used in almost all parts of Europe and America ; they are found under circumstances which indicate that man was contemporaneous with a number of extinct animals, such as the *Bos longifrons,* the Irish elk, the *Elephas primigenius,* and others. The stone knives and hatchets of this prehistoric period are found in great variety and number, and in some cases a blade or edge of obsidian was secured to a handle, or a row of arrow-heads or blades fastened in the grooved edge of a stock, forming a jagged knife or saw. This has been found among the sepulchral mounds of the Iroquois, and was also among the weapons of the people met by Herrera, who says : "The Indians had swords made of wood, having a gutter in the forepart, in which were sharp-edged flints strongly fixed with a sort of bitumen and thread." Among the Mexicans this toothed blade was armed with obsidian, and the Spaniards found it a very destructive weapon. Stephens found the same weapon represented in sculpture in the ruins of Central America and Yucatan. In process of time copper, then bronze, and then iron and steel, were introduced. For analyses of the ancient bronzes, see ALLOYS.

In the Egyptian mode of embalming dead bodies, and in practicing the rite of circumcision, a knife of flint, obsidian, or other sharp stone, was used. We read of it in Exodus where Zipporah took a sharp stone and used it for the latter purpose. Herodotus and Diodorus Siculus also refer to "sharp Ethiopic stone" as used in disemboweling corpses in the process of embalming, no knife of metal being allowed to be used upon the body. The custom of using a shard of flint has descended to our day among some of the nations who retain the practice of circumcision.

Under the head of cutlery are included knives of all kinds, scissors, shears, razors, and forks. It is only by a stretch of the term that it can be made to include edge-tools, such as axes, adzes, chisels, gouges, plane-bits, etc. These are not cutlery. See KNIFE ; SCISSORS ; SHEARS ; FORK ; RAZOR ; SURGICAL INSTRUMENTS ; DAMASKEENING ; FORGING ; TEMPERING ; SWORD, etc.

Cut-mark. A mark made upon a set of warp-threads before placing on the warp-beam of the loom, to mark off a certain definite length, the mark defining the end of which shall appear in the woven piece and afford a measure to cut by.

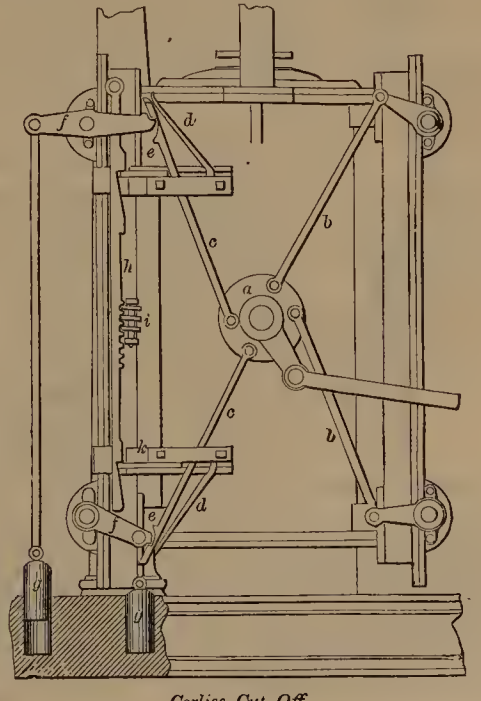
Cut-nail. A nail *cut* from a nail-plate, in contradistinction to one forged from a nail-rod, as a clasp, horse-shoe, or flat-head nail.

Mr. Odion, of Massachusetts, invented a machine for making cut-nails in 1816. Mr. Reed, of the same State, followed with another machine for the same purpose.

Walter Hunt's double-reciprocating nail-machine was introduced in 1841. See NAIL.

Cut-off. The term is applied to that mode of using steam or other elastic fluid in which it is admitted to the cylinder during a portion only of the stroke of the piston ; the steam, after the induction ceases, working expansively in the cylinder during the remainder of the stroke of the piston.

Fig. 1566.



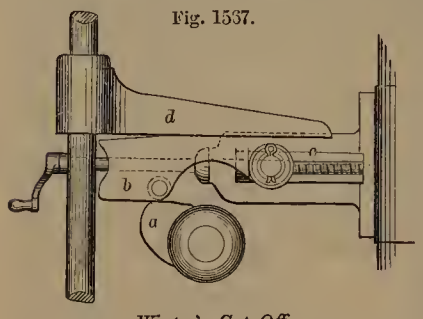
Corliss Cut-Off.

The *cut-off* in locomotive-engines is effected by a certain adjustment of the LINK-MOTION (which see).

The *cut-off*, in many steam-engines, is effected by the governor, which is so connected to the valve-gear as to vary the throw of the valve-rod, modifying it according to the speed of the engine; the effect being that an acceleration of speed works a diminution of steam inducted and conversely, the object being to secure uniformity of speed.

The CORLISS cut-off, 1851 (Fig. 1566), has an oscillating disk *a*, placed centrally on the cylinder with four pins, to which rods are attached, imparting motion to the valves. Two of the rods *b b* connect permanently with the exhaust, and two *c c* detachably by springs *d* and hooks *e* with the inlet-valves. Cranks *f* on the ends of the valve-stems fit into the hooks, and, becoming detached, close the valve by a weight *g*. A lifting-rod *h*, with rack operated by a worm-wheel *i*, and having inclines *k* bearing against stops, makes the valves adjustable.

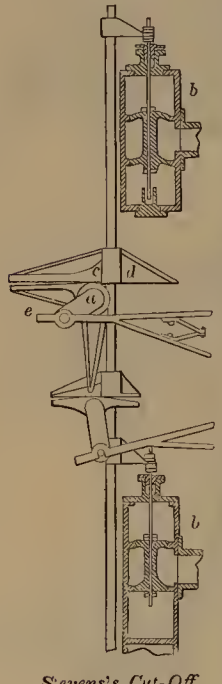
Fig. 1567.



Winter's Cut-Off.

WINTER'S cut-off, 1859 (Fig. 1567), has a crank on the main shaft, which imparts motion to a revolving shaft, arranged between the upper and lower steam-chests; a cam *a* on the shaft operates the swinging toe *b*, which is pivoted in a sliding, adjustable box *c* in a guide. A recess in lower side of said toe allows the cam to clear the toe when working full stroke, and the corner of the recess has a friction-roller which is struck by the cam, causing the lifters *d* to operate the valves. The swinging toes drop when the cam passes them.

Fig. 1568.



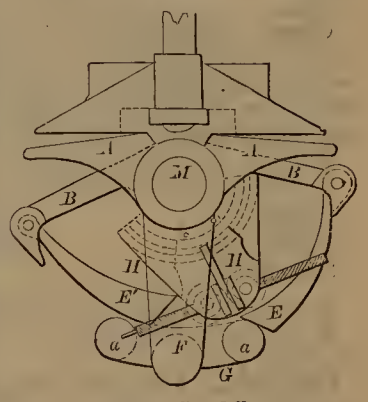
Stevens's Cut-Off.

In Stevens's cut-off, 1841 (Fig. 1568), a rotary shaft *a* is placed between the upper and lower steam-chests *b b*, and has two lifters *c d* placed on opposite sides of its center, which alternately raise and depress the valves by the toes *c* on the rock-shaft. To adjust the toes, a slot and pin are provided in the rock-shaft arm. To cut off shorter, the toes must be dropped, the pin raised, and the eccentric set ahead. To cut off longer, reverse the operation.

ALLEN AND WELLS'S cut-off, 1853 (Fig. 1569). Upon the rock-shaft *M* are arranged the loose steam-toes *B B*, with pawls *E E'* pivoted to their outer ends, which are raised by rollers *a a* on a cross-arm *G* of the rock-shaft arm *F*, and when they clear the rollers they drop inward, thus opening and closing the valves. To adjust them, two arms *H H* are provided with a right and left hand screw. The arms, having motion nearly coincident with the piston, start downwards at the same time the rock-shaft rises. The exhaust-toes *A A* are permanently attached.

In the gridiron valve (*A*, Fig. 1570) the steam-chest is divided by a longitudinal partition *b* provided with suitable ports, over which is arranged the cut-off valve *a*, and in the lower part of the chest is the usual slide-valve *c*.

Fig. 1569.

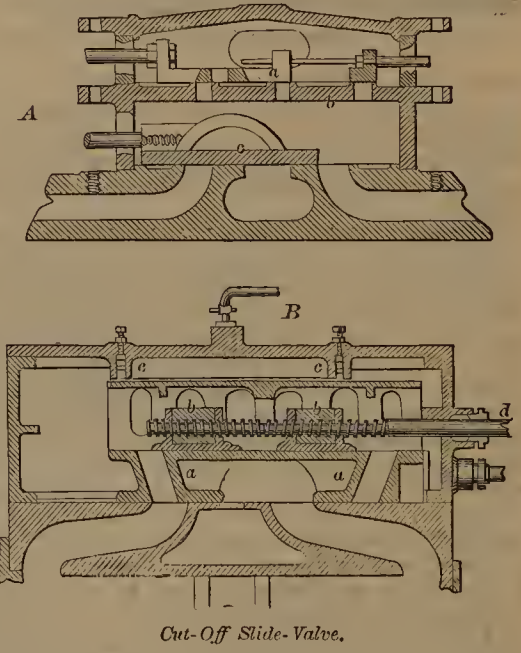


Allen's Cut-Off.

In the MERRICK cut-off (*B*, Fig. 1570) the steam-valve *a* is provided with ports through its lower part, over which the cut-off valves *b b* slide. They are made adjustable by a right and left hand screw on the valve-stem *d*, by which they may be drawn together or forced apart. In the steam-chest cover are arranged adjustable rings *c c*, that bear on the back of the valve *a* to make it a balanced valve. The space inclosed in the rings connects with the condenser.

SICKEL'S cut-off (Fig. 1571). A rock-shaft *a* operated by the rod *b* from the eccentric is placed midway of the steam-chests, and provided with the usual toes, by which the lifters *c* and rods *d d* of the valves are operated. To seat them without slamming, the valve-stems are provided with dash-pots *c c*; and to seat them suddenly, a spring-catch is secured on the stems, against which a vibratory wiper *g* passes, and, when released, the valves are seated instantaneously.

Fig. 1570.

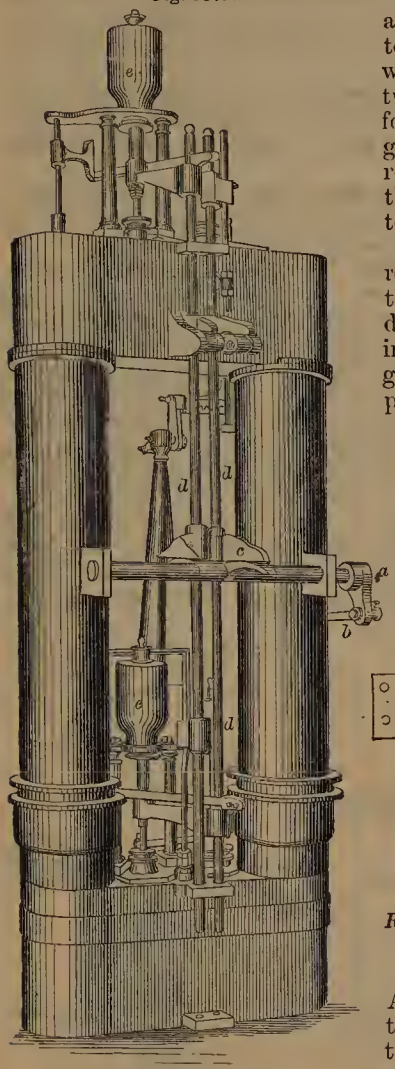


Cut-Off Slide-Valve.

A *drag cut-off* is one actuated directly by the main valve.

2. A valve or gate in a spout, to stop discharge; as in grain-spout when the required weight or quantity has been discharged or the receiving vessel is full.

Fig. 1571.

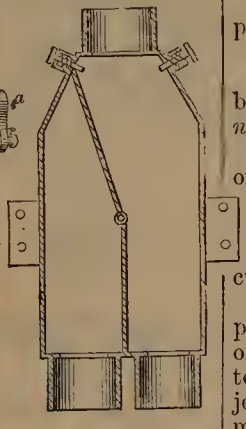


Sickel's Cut-Off.

3. A device in a rain-water spout to send the falling water in either of two directions, as, for instance, to the gutter until the roof is clean, and then to the cistern.

4. A rod on a reaper, to hold up the falling grain during the clearing of the fallen grain from the platform.

Fig. 1572.



Rain-Water Cut-Off.

Cut-off Valve. A valve arranged to close the induction-ports of a steam-cylinder at any given period before the close of the stroke of the piston, in order that the steam may be used expansively in the interval. See CUT-OFF.

Cut-out. (*Telegraphy.*) A species of switch used in telegraph-offices to connect the wires passing through the office, and "cut out" the instrument from the circuit. Usually a mere lever, pivoted between the wires leading to and from the instrument, so that, on being turned in the proper direction, it will connect the wires.

Cut-pile. (*Fabric.*) A fabric woven in loops, which are subsequently cut so as to give a pile (hairy) surface, such as velvet, plush, Wilton carpet, etc.

Cut-splay. The oblique cutting of the edges of bricks in certain kinds of fancy brick-work.

Cut-stone. A *hewn* stone. Ashlars reduced to form by chisel and mallet.

Cut'tee. The box to hold the quills in a weaver's loom.

Cut'ter. 1. (*Husbandry.*) That portion of a mower or reaper which actually severs the stalk. The varieties are numerous, but the general verdict of approval has been given to what may be called the *saw*,— a term which describes generally a device consisting of projecting teeth or *sections* affixed to a *bar* and reciprocated longitudinally of the latter. See HARVESTER-CUTTER.

2. (*Nautical.*) *a.* A vessel with one mast, having fore and aft sails. The spars are a *mast*, *boom*, *gaff*, and *bowsprit*.

Cutters are usually small, but the fancy has sometimes been to make them as large as 460 tons and 28 guns (the *Viper*). They are either clincher or carvel build; have no jib-stay, the jib hoisting and hanging by the halliards alone.

A cutter carries a fore and aft main-sail, gaff-topsail, stay, foresail, and jib.

b. A boat smaller than a barge, and pulling from four to eight oars. It is from 22 to 30 feet long, and has a beam equal to .29 to .25 of its length. A number are required for the miscellaneous purposes of a large ship, and are known as the first, second, etc., cutters.

3. A one-horse sleigh.

4. A soft brick adapted to be rubbed down to the required shape for ornamental brick-work or arches.

5. A wad-punch.

6. A revolving cutting-tool of a gear-cutter, a planing-machine, etc. See CUTTER-HEAD.

7. An upright chisel on an anvil. A *hack-iron*.

8. The *router* or scorper portion of the center-bit, which removes the portion circumscribed by the *nicker*.

9. A burin, an engraver's tool; as a *tint*-cutter or *tint-tool*.

10. A file-chisel.

11. A *peg-cutter*, or *float*.

12. (*Agriculture.*) An implement or machine for cutting feed. See STRAW-CUTTER; ROOT-CUTTER, etc.

Cutter-bar. 1. (*Boring-machinery.*) A bar supported between lathe-centers or otherwise in the axis of the cylinder to be bored, and carrying the cutting-tool. By various modifications having the same object in view, the tool-stock, cutter-bar, or cylinder may be moved, so as to cause the tool to pass around inside the cylinder or conversely, and also cause it to traverse from end to end. See BORING-MACHINE.

2. (*Harvester.*) A bar, usually reciprocating longitudinally, and having attached to it the triangular knives or sickles, which slip to and fro in the slots of the fingers, and cut the grain or grass as the machine progresses.

The bar carrying the fingers is the *finger-bar*.

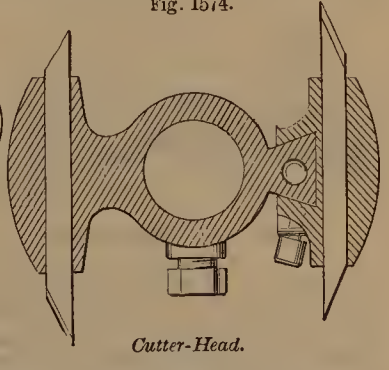
Cut'ter-grind'er. A grindstone or emery-wheel specially constructed for grinding the sections of the cutter-bars of reaping and mowing machines.

Cut'ter-head. A rotating head, either dressed and ground to form a cutter, or having means for the attaching of bits or blades thereto, as in the illustrations.

Fig. 1573.

Rotary Cutter.

Fig. 1574.



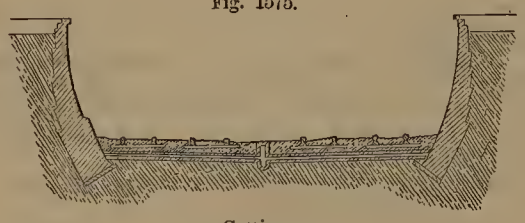
Cutter-Head.

Cut'ter-stock. A head or holder in which a cutting blade or tool is fastened for use.

Cut'ting. 1. (*Railroading.*) An excavation for the purpose of a road, railroad, or canal. When the earth is not required for a *fill* or embankment, it is called *waste*.

When the sides are not secure, sufficient slope must be allowed or retaining-walls constructed.

Fig. 1575.



Cutting.

These walls *batter* towards the bank in order to withstand the thrust. See BATTER; BREAST-WALL; RETAINING-WALL.

2. (*Mining.*) A poor quality of ore mixed with that which is better.

Cut'ting-board. A board for the bench or lap, in cutting out leather or cloth for clothing.

Cut'ting-box. A machine for cutting hay, straw, or corn-stalk into short feed. See STRAW-CUTTER.

Cut'ting-com'pass. A compass, one of whose legs is a cutter, to make washers, wads, and circular disks of paper for other uses.

Cut'ting-down Line. (*Shipbuilding.*) A curved line on the sheer-plan, which touches the lowest part of the inner surface of each of the frames. It determines the depth of the floor-timbers and the hight of the dead-wood fore and aft.

Cut'ting-down Staff. (*Shipbuilding.*) A rod having marked upon it the hight of the *cutting-down line* above the keel at the several frames.

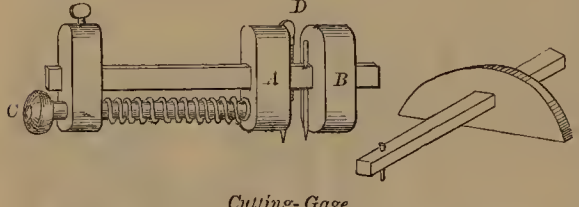
Cut'ting-en'gine. (*Silk-machinery.*) A machine in which refuse or floss silk — the fibers having been previously disentangled, straightened, and laid parallel by the HACKLE, FILLING-ENGINE, and DRAWING-FRAME (which see) — are cut into lengths of about 1¼ inches, so as to enable them to be treated as a staple by the carding-machine and the machines which follow in the cotton process, bringing the fiber to a *sliver*, a *roving*, a *thread*, suitable for weaving.

The cutting-engine has feed-rollers, and an intermittingly acting knife, somewhat similar to a chaff or tobacco cutter.

Cut'ting-file. The toothed cutter of a gear-cutting engine.

Cut'ting-gage. A tool having a lancet-shaped knife (one or two) and a movable *fence* by which the distance of the knife from the edge of the board is

Fig. 1573.



Cutting-Gage.

adjusted. It is used for cutting veneers and thin wood. In the West, linn-wood, sawed *through and through* the width of the log, ¼ to ⅜ inch thick, is ripped into plastering-lath by the cutting-gage, after a straight edge has been once established.

Cut'ting-line. (*Printing.*) A line made by printers on a sheet to mark the *off-cut;* that which is cut off the printed sheet, folded separately, and set into the other folded portion.

Cut'ting-ma-chine'. 1. A machine for reducing the length of staple of flax. See BREAKING-MACHINE.

2. A machine for cutting out garments. A reciprocating vertical knife works in a slot of the table which supports the pile of cloth to be cut. The cloth is fed by the attendant so as to bring the line marked on the upper layer in line with the knife.

Cut'ting-nip'pers. A pair of pliers whose jaws are sharp and come in exact apposition. The cutters are sometimes on the face of the jaws and sometimes on the side.

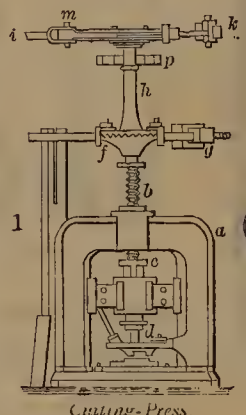
Cut'ting-out Ma-chine'. One by which planchets for coin, or blanks for other purposes, are cut from ribbons of metal. See CUTTING-PRESS.

Cut'ting-plane. A carpenter's smoothing-plane.

Cut'ting-press. 1. A screw-press for cutting planchets of metal from strips. The *cutting-press* of the coining-apparatus (1, Fig. 1577) has a cast-iron frame *a*, which is fixed on a stone basement; *b* is the screw, which is fitted through the top of the frame, and actuates a slider *c*. At the lower end of the slider a steel punch *d* is fixed. Its diameter is exactly equal to that of the pieces which are to be cut out.

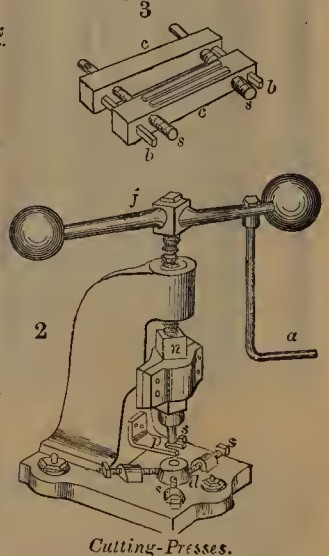
Beneath is the steel die, which has a hole in it of proper size to fit the steel punch. On the other side is a box with screws for adjusting the die, so that the hole in it will be exactly beneath the punch.

Fig. 1577.



Cutting-Press.

Fig. 1578.



Cutting-Presses.

The slide *c* is fitted into a socket, which guides it so that it will descend correctly into the hole in the die; a piece of iron is fixed a small distance above the die, and has a hole through it to admit the punch. Its use is to hold down the piece of metal when the punch rises, otherwise the piece would stick to the punch.

On the upper end of the screw, a piece *f* is fixed, and an arm projects from it, with a weight *g* at the end; and it is this weight which gives the necessary momentum to punch out the piece; *h* is a spindle fixed upon the piece *f*, in the line of the screw; it is supported in a collar *p* at the upper end, and above the collar a lever *i m k* is fixed, and at one extremity of this lever a roller *k* is placed; this is acted upon by projecting teeth, which are fixed in the rim of a large horizontal wheel, which is turned round by the prime mover of the mill, and thus produces the requisite motion in the whole apparatus.

2 (Fig. 1578) is a modified form in which *a* is the tail of the weighted swinging-lever *f*, which is moved by hand, to move the slider *n* and the punch. The lower die *d* is adjusted in position by the system of set screws *s*, on the bed-piece; *p* is the holding-down plate.

2. A bookbinder's press (3, Fig. 1578) for hold-

ing a pack of folded sheets while the book is sawed previous to sewing, or for holding the sewed book for edge-cutting. The screws *s s* pass through the side-pieces *c c*, which are steadied by sliding-guides. The pack may now be plowed or saw-cut on the back for the twines to which the sheets are sewed.

Cut'tings. (*Metallurgy.*) The larger and lighter refuse which is detained by the sieve in the *hotching-tub*, or *hutch*.

Cut'ting-shoe. A horseshoe with nails on only one side, for horses that *cut* or *interfere*. A *feather-edge shoe*.

Cut'ting-thrust. A tool like a *cutting-gage*, employed in grooving the sides of boxes, etc. It has a *routing*-cutter in a stock, and an adjustable sliding-head which forms a gage for distance from the guide-edge of the board.

Cut'toe-plate. A hood above the nave or hub of a vehicle, to prevent the street mud from falling upon the axle and becoming ground in between the axle-box and spindle. Otherwise called a *dirt-board*, or *round robbin*. It is attached to the axle or bolster.

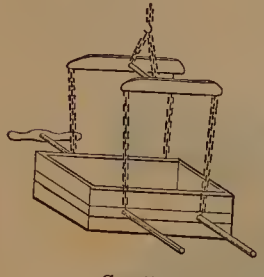
Cut-vel'vet. (*Fabric.*) Piled goods in which the loops are cut.

Cut-wa'ter. 1. (*Shipwrighting.*) The forward edge of the *stem* or *prow* of a vessel; that which divides the water right and left. It is fayed to the forepart of the stem.

2. (*Bridge.*) The edge of a *starling* presented up stream, to divide the waters on each side of the *pier*.

Cu-vette'. 1. (*Glass.*) A basin for receiving the melted glass after it is refined, and decanting it on to the table to be rolled into a plate.

Fig. 1579.



Cuvette.

The *cuvettes* stand in openings in the sides of the furnace, and are filled with melted glass from the pots by means of iron ladles. The material remains sixteen hours in the pots and sixteen in the *cuvettes*. In casting, the *cuvette* is lifted by means of a gripping-tongs, chains, and a crane, and the contents are poured upon the casting-table.

2. (*Fortification.*) A ditch in the main ditch.

Cy'a-nom'e-ter. Invented by Saussure, for determining the depth of the tint of the atmosphere.

A circular band of thick paper is divided into fifty-one parts, each of which is painted with a different shade of blue; the extremities of the scale being respectively deep blue and nearly white. The colored band is held in the hand of the observer, who observes the particular tint corresponding to the color of the sky. The number of this tint, reckoning from the light end, indicates the intensity of the blue.

Cy-an'o-type. (*Photography.*) A process by Sir John Herschel in which cyanogen is employed. One form of the process is as follows: —

A paper is washed with ferridcyanide of potassium and dried; placed under a frame, the parts exposed to light are changed from yellow to blue (Prussian blue). The picture is washed, then fixed by carbonate of soda, and dried. The picture before washing is lavender on a yellow ground, but washes out to a blue on a white ground. It is rather curious than really useful. The process has several variations.

Cy'clo-graph. More properly ARCOGRAPH (which see).

Cy-cloid'al En'gine. An instrument made use of by engravers in making what is called *machine-work* upon the plates for bank-notes, checks, etc.

The lines have a general *cycloidal* form, being generated by a point revolving around a moving center, or, what amounts to the same, are cut by a graver-point to which a revolution is imparted, the plate traversing below in a straight line, a waved line, a circle, ellipse, or other figure. The line is thus compounded of two movements, and a wavy or complex interlacing figure of absolute regularity is produced as a guard against counterfeiting; it being impossible to produce such work by any means other than such a tool. Counterfeiting, being an underhand proceeding and seeking secrecy, is followed by skillful men, but without the expensive and complicated mechanical adjuncts.

Cy-cloid'al Pad'dle. The name is a misnomer, but is applied to a paddle-wheel in which the board is divided longitudinally into several strips in a slightly retreating order, *en echelon*. The object of the division of the float is to bring the sections in succession into the water, lessening the concussion; and by a more complete distribution of floats around the circumference of the wheel to make the resistance more uniform.

Cyl'in-der. 1. (*Steam-engine.*) That chamber of a steam-engine in which the force of steam is utilized upon the piston.

For more than ten years Watt's conception of the steam-engine could not be realized in practice, owing to the impossibility, with the appliances then at hand, of constructing a piston and cylinder air-tight. Mr. Boulton of Soho came to his relief with capital and mechanical skill.

2. (*Pneumatics.*) The barrel of an air-pump, such as used by Hero of Alexandria (see the *Spiritalia*), and that of Otto Guericke of Magdebourg. See AIR-PUMP.

Perhaps the earliest use of the cylinder and piston is found in the blowing-machines of native metallurgists in portions of Asia and Africa.

3. The *cylinder* of the Jacquard loom is really a square prism revolving on a horizontal axis and receiving the cards.

4. A clothed barrel in a carding-machine. *Urchins* and *doffers* are clothed cylinders of smaller size.

5. The glass barrel of an electrifying-machine.

6. (*Printing.*) *a.* An inking-roller of a printing-machine.

b. The cylinder of some forms of printing-machines carries the type in *turtles*.

7. The bore of a gun. The *charge* cylinder is that occupied by the charge; the *vacant* cylinder is the remaining portion.

8. A wooden bucket in which a cartridge is carried from the magazine to the gun.

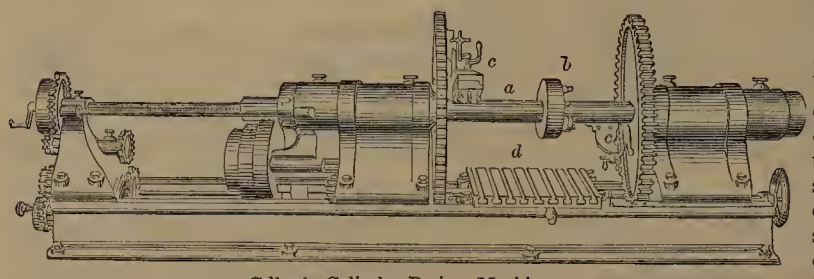
9. The body of a pump.

10. A garden or field roller.

Cyl'in-der-blow'er. A blowing-machine for blast and cupola furnaces, which consists of a piston working in a cylinder. See BLOWER.

Cyl'in-der Bor'ing-ma-chine'. (*Metal-working.*) A machine having face-plates on which the cylinder is dogged concentrically with the axial boring-bar on which a tool-holder has longitudinal feed, to move from end to end of the cylinders. The bar draws entirely out, to allow the work to be shifted, and independent slide-rests face off the ends of the cylinder.

Fig. 1580.



Sellers's Cylinder Boring-Machine.

Cyl'in-der-cock. (*Steam-engine.*) A faucet in the end of a cylinder to allow water of condensation to escape when the piston approaches the said end of the cylinder. Owing to the incompressibility of water, the end of the cylinder may be driven out, if the water be allowed no means of escape. It is also used to allow the passage of steam in blowing through the cylinder, etc., in warming up. It is then, functionally, a blow-through cock.

When the cylinder-cock is made automatic, it has a spring to keep it closed against the normal pressure of steam, but which yields to the excessive pressure in the cylinder incident to the striking of the piston against a body of water, the result of the condensation of steam in the cylinder.

Cyl'in-der-cov'er. (*Steam-engine.*) The lid bolted to a flange round the top of a cylinder, so as to be perfectly steam-tight. The piston-rod passes through a stuffing-box in the center.

The term is also applied to the *jacket*, *lagging*, or *cleading*, which prevents to some extent the radiation of heat.

Cyl'in-der-en'gine. A paper-machine in which the pulp is taken up on a cylinder and delivered in a continuous sheet to the dryers.

Cyl'in-der Es-cape'ment. Another name for the horizontal escapement invented by Graham. See HORIZONTAL ESCAPEMENT.

Cyl'in-der Es-cape'-valve. A valve in the end of a cylinder to let off water of condensation.

Cyl'in-der-glass. A mode of making window-glass, in which the material is brought, by a succession of operations, to the shape of an open-ended cylinder, which is split by a diamond and flatted in a furnace.

Although this plan had long been practiced in Germany and Belgium, it was not imported into England until about 1846, owing to the vexatious excise-regulations, all improvements in glass-working being hampered and well nigh prevented. The imposition, however, was taken off in time for the manufacture of cylinder-glass for the World's Exposition building in London, 1853.

We are not aware that it has yet been introduced into the United States.

As remarked, this mode of making flatted glass was no new thing, but is described in the *Diversarum Artium Schedula*, written probably in the thirteenth century.

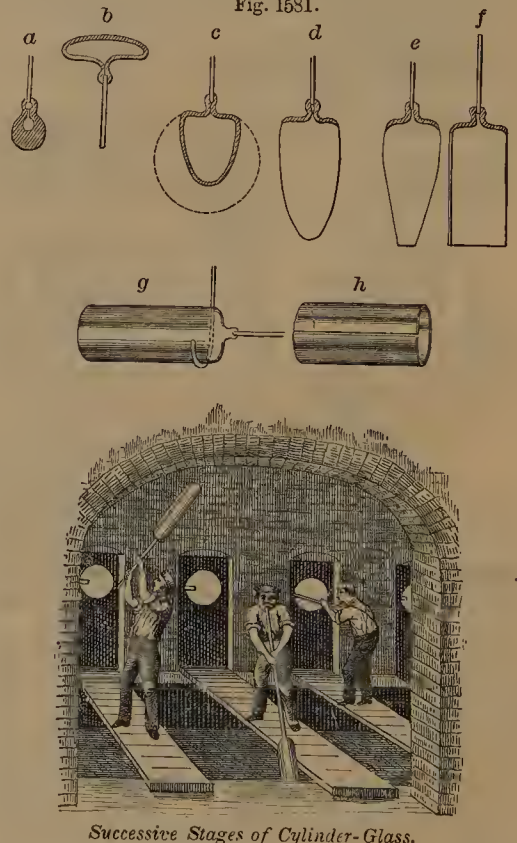
While *crown-glass* is blown into a globe, then whirled and blown into an oblate spheroid, pierced and eventually expanded into a disk, *cylinder-glass* or *broad-glass*, as it is often called, is made into a hollow bulb, which is made gradually to assume the cylindrical form; the ends are opened by means to be described, finally the cylinder is split and flattened.

The process is as follows: —

The workman collects a mass of the glass *a* around the end of his blowing-tube, and then distends and rounds it by blowing and rolling on the *marver*, or flat, cast-iron table. The subsequent operations consist in reheating, blowing, and swinging until the diameter, and then the length of the cylinder required, are attained, the glass successively assuming the forms *b c* represented in the figure. In the fourth stage, where it has assumed a conoidal form *d*, the point is very thin, and the blower, having filled the shell with air at a pressure, places it in the furnace, when the expansion of the air by heat causes the conoid to burst at the apex *e*. The edge of the hole is then trimmed with shears, and enlarged by the *pucellas*, a peculiar hand-tool which resembles a pair of spring sugar-tongs with flat jaws. The cylindrical form *f* being then perfected, the cylinder is ready to be removed from the blowing-tube, a circular piece of glass coming away with the tube so as to make an opening in the other end of the cylinder.

This separation is effected by a red-hot bent iron, in which the cylinder is turned round a few times,

Fig. 1581.

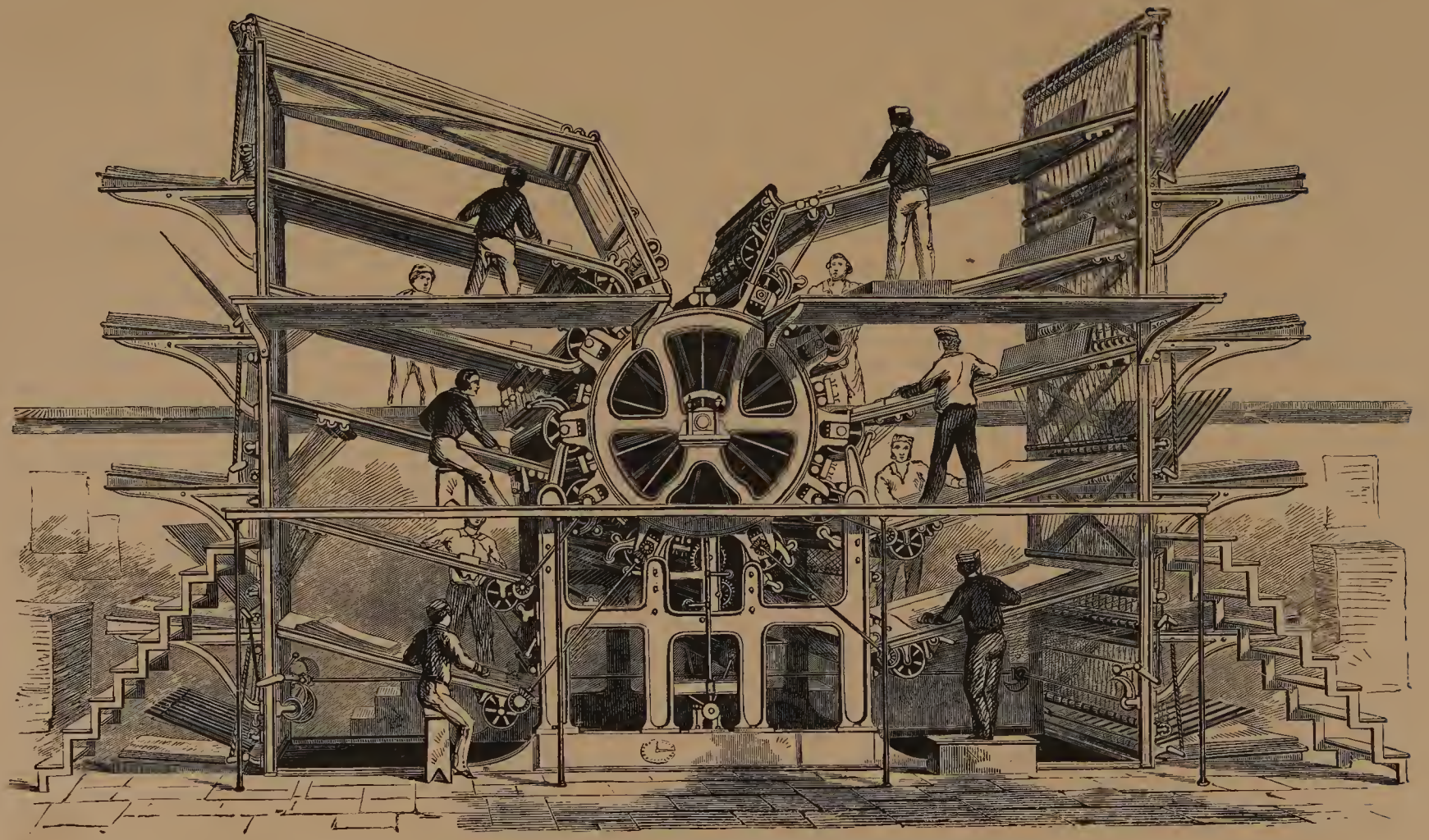


Successive Stages of Cylinder-Glass.

so as to expand the glass at that point *g*. A drop of water on the heated line makes an instant fracture.

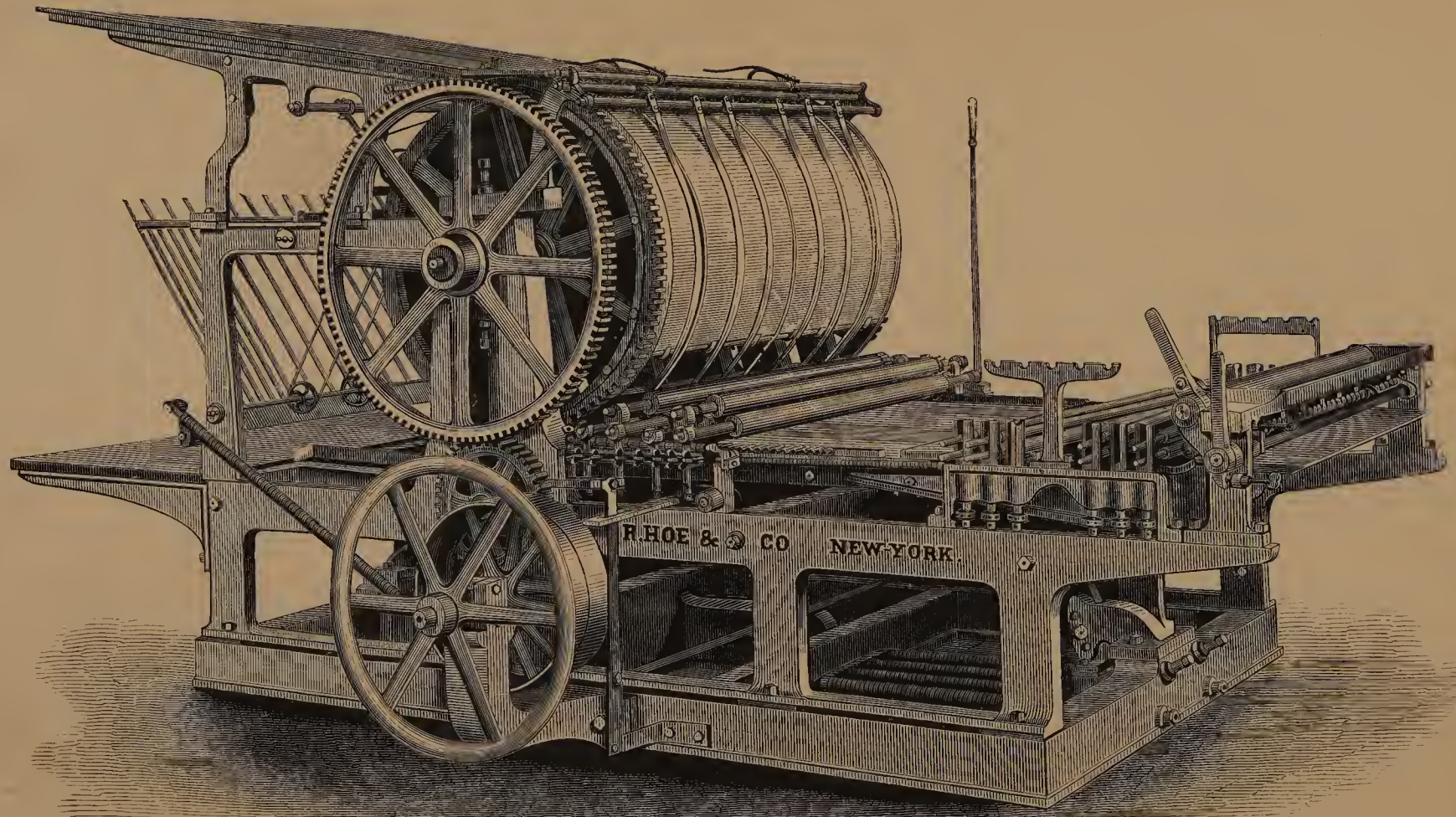
The cylinder is then split by a diamond or by means similar to that which removed the disk from the end *h*.

Flatting and *annealing* finish the process. These are accomplished in separate furnaces, or apartments heated by the same furnace. (See FLATTING-FURNACE.) In the combined form it consists of consecutive chambers heated by a furnace beneath. The cylinder is placed on the heated floor of the flatting-furnace, with the cracked side uppermost; the heat



HOE'S TEN-CYLINDER TYPE-REVOLVING PRINTING-MACHINE.

See page 670.



SINGLE LARGE-CYLINDER FOUR-ROLLER PRINTING-MACHINE.

PLATE XII.

See page 671.

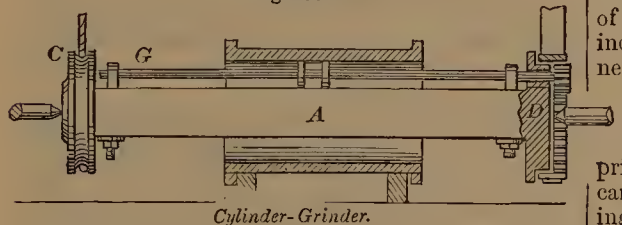
of the furnace causes it to soften and spread out, when all curves and lumps are removed by a straight piece of wood, fastened crosswise at the end of an iron handle and wetted before applying. The flatting-stone is made very smooth, as any inequalities are transferred to the glass. The sheet of glass is then pushed into the annealing-chamber, where it is set upon edge and left to cool gradually.

The operations of making crown and cylinder glass are exceedingly interesting, and have some marked peculiarities. Wonderful is the command attained by skill over the plastic stuff, and in no other art except pottery is there such a growth beneath the hand of the operator.

The illustration shows the men, each on his platform, one swinging his prolonged bulb above his head, another blowing and swinging it below his feet, while a third is observing the operation of heating the glass, which he keeps constantly turning round by means of the rod in his hand, to which it is attached.

Cyl'in-der Grind'ing-ma-chine'. A machine for trueing and polishing the insides of cylinders. The cylinder is secured to the slide-rest, and moves aloug on the ways longitudinally of the mandrel *A*,

Fig. 1582.



Cylinder-Grinder.

which is mounted on eenters, and rotated by the band-wheel *C*. The inside is fixed, and, as the mandrel *A* and head *D* rotate on their axis, the rod *G*, carrying the grinding-disks, is caused to revolve around the said axis, and at the same time rotate on its own axis, carrying the disks.

Cyl'in-der-mill. One form of mill for pulverizing the ingredients of gunpowder, haviug a cylindrical runner traversing on a bedstone.

Cyl'in-der-pow'der. That of which the charcoal is made in iron cylinders.

Cyl'in-der-press. (*Printing.*) *a.* A form of press in which the type is secured on a cylinder which revolves and presents the form successively to the inking-rollers and to the paper. The *type-revolving printing-machine* of Hoe is of this class, and is shown in the full-page cut opposite. These machines are made with two, four, six, or ten printing-cylinders arranged in planetary form around the periphery of the larger type-carrying cylinder. The type is secured in turtles, or the stercotype is bent to the curve of the cylinder. The circumference of the latter has a series of binary systems, tne elements of which are an inking apparatus and an impression apparatus, the paper being fed to the latter, and the printed sheet carried away therefrom by tapes to a flyer, which delivers it on to the table.

b. One in which the form is placed upon a bed and the impression taken by a cylinder, which takes a sheet and receives an impression from the form while it is passing under them. These are known as *double*, *single*, *small*, *large*, *stop*, cylinder-presses.

In the *double* cylinder-press two cylinders are used, which take sheets alternately. The *single* has but one, and needs but one attendant feeder; the printed sheets are thrown down by a fly-frame.

The accompanying full-page illustration is of a press known distinctively as a *single large cylinder printing-machine*, in which the form runs beneath four rollers. The feed is by fingers on the cylinder, taking sheets from the inclined feed-board above, and passing them between the cylinder blanket and the form, the cylinder and bed-rack gearing together during this portion of the motion of each. The printed sheet is delivered by a flyer.

The *stop-cylinder* press is one in which, after a sheet is printed, the cylinder remains stationary while the bed is running back, during which time a fresh sheet is placed in position.

In the stop-cylinder press, designed for woodcut printing, special arrangements are made for inking, — by a vibrating cylinder or inking-table, as may be desired, — and the number of form-rollers may be proportioned to the character and size of the work, being usually adapted to the size of the bed. The impression-cylinder is stationary during the return of the bed, and the fingers close on the sheet before the register-points are withdrawn; the cylinder then revolves, and it gears directly into the bed, and perfect register is obtained. The bed is arranged to run once, twice, or thrice beneath the inking-rollers to each impression, so as to secure a more perfect distribution of the ink.

Cyl'in-der-print'ing. 1. (*Printing.*) A mode of printing in which the type is secured to the cylinder, or the paper on a cylinder which acts in connection with a rolling-bed. See CYLINDER-PRESS.

2. A system of printing calicoes by engraved copper cylinders, invented in Scotland and perfected in England. These are engraved on the Perkins principle, by which a small roller with the design in cameo is impressed against the surface of the revolving cylinder, delivering upon the latter the design in intaglio as many times repeated as the circumference of the small steel cylinder (the *mill*) is contained in the circumference of the copper cylinder.

This is the principle of the American system of bank-note engraving. See TRANSFERRING-MACHINE.

Cyl'in-der-tape. (*Printing*). A tape running on the impression-cylinder beneath the edge of the paper, to remove the sheet from the cylinder after printing.

Cyl'in-der-wheel. A form of scape-wheel, used in the *horizontal* or *cylinder* escapement.

Cyl'in-der-wrench. A form of wrench adapted to grasp round rods or tubes. See PIPE-WRENCH.

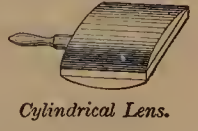
Cy-lin'dri-cal-arch. (*Architecture.*) One which is a prolongation of the same curve throughout its length.

Cy-lin'dri-cal Boil'er. A boiler of a cylindrical shape, in contradistinction to the other and earlier forms.

The cylindrical boiler was introduced into Cornwall, England, in consequence of the use of a higher pressure of steam, which rendered the *haystack*, *hemispherical*, and *wagon* boilers unsafe. (See CORNISH-BOILER). Smeaton introduced the flue into the boiler. The cylindrical return-flue boiler was patented by Wilkinson in 1799.

Cy-lin'dri-cal Lens. A reading-glass whose back and front faces are formed by cylindrical surfaces, the diameters of which are at right angles to each other: the form being that of two segments of cylinders united at their bases.

Fig. 1583.

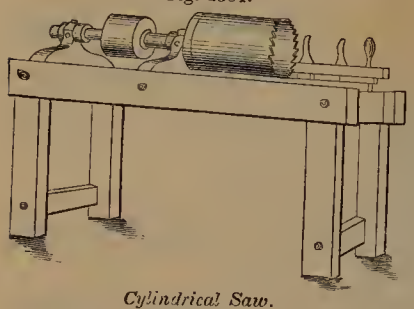


Cylindrical Lens.

A lens having a cylindrical body and convex ends. A *Stanhope* lens.

The term may also include a lens consisting of a true cylinder which gives a line of light; or of cylindrical segments parallel to each other, which com-

Fig. 1584.



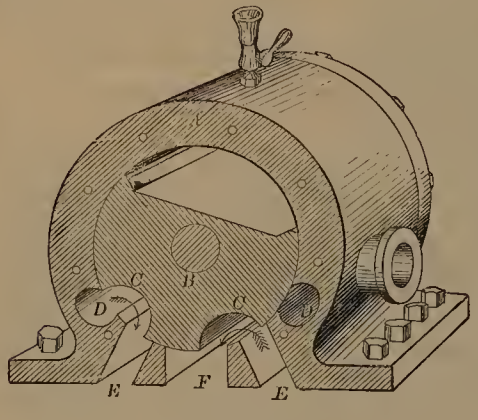
Cylindrical Saw.

bination also gives a line of light.

Cy-lin'dri-cal Saw. A saw having a cylindrical form and sharpened at one end. Used in sawing staves from the block, giving them a transversely rounded form; for sawing felloes, chair-backs, etc. It is on the principle of the crown-saw, and is variously called a *tub-saw*, *drum-saw*, *barrel-saw*, etc.

Cy-lin'dri-cal Valve. (*Steam-engine.*) A valve in a trunnion or elsewhere having a cylindrical shape

Fig. 1585.



Cylindrical Valve.

and oscillating on its axis, to open and close ports in the cylindrical case which forms its seat.

Cy'ma Rec'ta. A form of waved or ogee molding hollow in its upper part and swelling below. *Cymatium.* See MOLDING.

The member below the abacus or corona.

Cy'ma Re-ver'sa. An ogee in which the hollow member of the molding is below. See MOLDING.

Cym'bals. Disks of bronze, more or less basin-shaped, clashed together or lightly touched in accord with the music. They are very ancient, being represented in different forms upon the sepulchral monuments. They were used by the Levites in the temple ordinances, and the sons of Asaph excelled in their use. They are mentioned among other instruments, 1043 B. C., when David brought the ark home, — *harps, psalteries, timbrels, cornets, cymbals* (2 Sam. vi. 5).

The *loud-sounding* and *high-sounding* cymbals mentioned in Psalms cl. 5, were probably the clashing cymbals and rattling castanets.

The accompanying illustration shows the cymbals of ancient Egypt. They have been found in the tombs of Thebes, and those shown are now in the collection of Mr. Salt. They are about 7 inches in diameter, and are of an alloy which does not seem to have been determined analytically. Quite likely they are of bronze, with a possible addition of some silver.

Fig. 1586.

Egyptian Cymbals (Salt's Collection).

A small variety of cymbals played with the finger and thumb resemble castanets in the mode of using to beat the measure of the dance. They are shown in the paintings of Herculaneum, and were sometimes attached to the ankles of the flute-players. See CASTANETS.

Cymbals are also represented in the sculptures of Nimroud.

The cymbals were used in religious and patriotic observances by the Egyptians, Assyrians, Jews, Etrurians, Greeks, and Romans; by the Greeks in the worship of Cybele, Bacchus, and Juno; indeed, Xenophon says that the cymbal was invented by Cybele, and used at her feasts, at a period corresponding to our date of 1580 B. C.

The origin of the cymbal was evidently heroic; swords and shields being clashed in the warlike dances of the semi-barbarous people of the countries bordering on the Mediterranean.

In a Persian dance of the times of Cyrus and Cambyses, the movements were performed to the music of the flute, the performers dashing their crescent-shaped shields together, falling on one knee, and rising.

The corybantian dance of Crete and Phrygia was a wild, warlike performance, with the same rattling accompaniment. The Pyrrhic dance, as described by Plato, was a frantic exhibition of evolutions and tumblings, representing the modes of dodging and warding off the blows of swords, daggers, and spears, and was performed to the jarring music of clashing weapons. The modern Greeks, who

"... have the Pyrrhic dance as yet,"

have emasculated the performance, which threw into the shade anything else on record, including the ferocious and disgusting dances of the redskins of the West.

"My lord called for the lieutenant's cittern, and with two candlesticks with money in them for symbols (*sic*), we made barber's music." — PEPYS, 1660.

Cys'to-tome. (*Surgical.*) An instrument for cutting into a cyst, natural or morbid, such as opening the bladder for the extraction of urinary calculi, opening the capsule of the crystalline lens, etc. *Cystitome.*

D.

Dab. An impression in type-metal of a die in course of sinking.

Dab'ber. 1. (*Printing.*) The original inking-apparatus for a form of type. It consisted of a ball of cloth stuffed with an elastic material. Two of them were used, one in each hand. One of them being dabbed upon the inking-table to gather a quantity of ink, the balls were then rubbed together so as to spread it uniformly. This was done while the *pull* was being made, and when the bed was withdrawn from below the platen, and the printed sheet removed, the assistant, working actively with both hands, inked the surface of the form.

Fig. 1587.

Dabber.

Another form of dabber is a roll of cloth, the end of which is used for inking the engraved copper-plate.

2. (*Engraving.*) A silk ball, stuffed with wool, for spreading the *ground* upon the hot plates.

3. (*Stereotyping.*) In the paper process, the insinuation of the damp paper into the interstices of the letters by dabbing the back of the paper with a hair brush.

The term has also been applied to the cliché process, in which the *form* is dabbed down into a shallow cistern of type-metal which is just setting.

Dab'bing-ma-chine'. (*Type-founding.*) The machine employed in casting large metal type.

Dac-tyl'i-on. (*Music.*) (*Dactyl*, Gr., a joint.) An instrument invented by Henry Herz for training the fingers and suppling the joints. See Moore's "Encyclopedia of Music." See also CHIROPLAST.

Da'do. (*Architecture.*) A plain flat surface between a base and a cap or corona of a plinth. A *die.* The space between the base and surbase of a room.

Dag'ger. 1. A weapon with a pointed blade, adapted for stabbing.

Fig. 1588.

Daggers.

The words *dag* and *dagger* came into use about the twelfth century, but the knife is as old as Cain, or Abel it might be said, as he butchered sheep, and brought them and the fat thereof as a sacrifice.

The Romans carried secreted daggers (*dolo*) hidden in the handles of whips and canes.

The Venetians had daggers of glass with three-edged blades and a tube to secrete poison. By a sudden wrench the blade was broken off and remained in the wound, like the arrow-head of an Apache. Nice people both!

The *dagger* was a part of the equipment of the Frank warrior, who probably called it a *coutel*, or something like that. It does not differ materially from the *dirk* (*durk*, *duirc*) of the Gadhelic branches of the Celts, or the *poniard* of those nations who acknowledge Latin (*pungere*, Lat., to prick) as the base of their mother tongues.

In the fourteenth century it was carried by citizens, yeomen, sailors, and ladies. It survives in England in the midshipman's *dirk*, and in other places as a *stiletto*, a *bowie-knife*, etc.

The *dagger* seems to have been a favorite instrument as an accessory to the soldier's equipment for close combat. The Highlander, Western desperado, and Chilian, all seem to approve of the mode of carrying it recorded of Ehud 1336 B. C.: "Ehud made him a dagger which had two edges, of a cubit length, and he did gird it upon his right thigh" (Judges iii: 16). The modern plan seems to be in the garter or the boot, unless it be worn in the belt, bosom, or down the back; *mirabile dictu*, such was known on the Mississippi and by "Arkansaw travelers."

Some ingenuity has been expended on this weapon in the mode of attaching it to the handle and providing the latter with a pistol.

2. (*Printing.*) A character (†) to call attention in the text to notes on the foot or margin of the page. As a reference-mark it comes next after the star (*).

A double dagger (‡) is another sign for a similar purpose when references are numerous.

Dag'ger-piece. (*Shipbuilding.*) A *diagonal* piece in a ship's frame; as, *dagger-knee*, *dagger-wood*, etc.

Dag'ger-plank. (*Shipbuilding.*) One of the planks which unite the *poppets* and *stepping-up pieces* of the cradle on which the vessel rests in launching.

Da-guerre'o-type. The photographic process invented by Daguerre during the years 1824–39, resulting in the use of the camera for the exposure of a silver or silvered plate, sensitized by exposure to fumes of iodine in a dark chamber. The latent image was developed by fumes of mercury and fixed by hyposulphite of soda. In 1829, Daguerre was joined in his experiments by Niepce, who had been experimenting for fifteen years with an allied process in which a plate coated with asphaltum was exposed in a camera, the image developed by dissolving away the unalloyed portions by oil of lavender. The French government granted a pension of 6,000 francs to Daguerre, one half to revert to his widow; 4,000 francs to Niepce's son, with reversion of one half to his widow. Niepce died in 1833, Daguerre in 1851.

Da-guerre'o-type Etch'ing. A mode of etching by means of the influence of light on a prepared plate. The plate becomes exposed where the dark lines of the image fall, and the plate is corroded at those places by a subsequent operation.

Dahl'gren Gun. Named from the late rear-admiral John A. Dahlgren, of the United States navy. A gun in which the front portion is materially lightened and the metal transferred to the rear, giving the "bottle-shape," which caused some surprise on their first appearance in Europe.

Colonel Bomford, chief of ordnance of the United States army, commenced making this experiment previous to the war of 1812, and gave the name of "Columbiad" to the piece.

Da'is. A raised platform at the upper end of a room, of a dining-hall, or room of ceremony. On it the dining-table of celebrities was placed. Its present use is for a throne or rostrum.

Dale. A spout or trough to carry off water; as a *pump-dale*.

Dam. 1. A bank or structure across the current of a stream.

Dams for reservoirs are among the most important of all embankments, as their failure entails such extensive disasters.

The dam of the Estrecho de Rientes, in Spain, was situated in a valley a little above the town of Lorea, and was designed to hold the water to a hight of 167 feet. After eleven years' use the weight of water, which had attained a hight of 156 feet, April

30, 1802, burst the wall, making a tunnel 100 feet high and 70 feet broad, discharging the whole contents in less than an hour.

The catastrophe was caused by the water finding its way through the sand and gravel at the bottom of the valley.

608 persons were drowned, 809 houses destroyed, and the damage to property was estimated at $700,000.

The thickness of the crown was 36 feet, and the slope of the surface away from the water was 2 feet in hight to 1 base.

The dam of the reservoir of Alicante is circular, the convex side up stream. It is struck with a radius of 350 feet, is 67 feet thick at the top; the masonry batters up stream 10 feet. The thickness at the bottom is 112 feet.

It is executed of a hard primary limestone rock, and the overflow is made in two streams, each 6 feet wide and 7 feet below the crown of the dam, which has an inclination from the surface of the dam of 3 feet 4 inches. Notwithstanding the capacity of the overflow water-way, the reservoir has been several times filled to the level of the top, the water washing over.

On September 8, 1792, after a protracted storm, the water rose to a hight of 8 feet 3 inches above the top of the dam, pouring over it in a magnificent cascade. Such confidence was given by its stability on that and other occasions that the overflows were closed, the waste water tumbling over the wall.

Herrera, the architect of the Escurial, was the author of this magnificent project, which was executed between 1579 and 1594. The depth of water, when full, is 134 feet 6 inches, and the storage capacity 131,000,000 cubic feet.

The Tanks of Ceylon are among the wonders of hydraulic engineering; as, for instance, the chain of tanks which unite the ancient capital Pollinarua with Tamblegam Bay and Trincomalee. Some of these are artificial lakes twenty miles in circumference, formed by embankments of massive masonry that seem to defy the hand of time. They form part of a vast system of irrigation.

Similar structures are found in Southern India and Arabia, and point to the occupation of those countries by the same race; a civilized people, older than the Arabs and Hindoos.

In England the dams of reservoirs are usually earthworks, the dependence for tightness being a *core* or wall of puddle, commencing in a trench below the foundations and carried up to within a few feet of the top. The puddle forms a water-tight wall in the bank, and averages in thickness about one third the hight of the embankment.

The embankment has an internal slope of 1 hight to 3 base; the external slope, 1 hight to 2 base; the width on top, 20 feet.

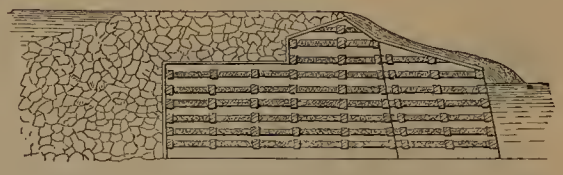
The earthwork is carried up in layers of from 4 to 6 inches, carefully rammed.

In France the main dependence for tightness has been work in hydraulic lime, in the use of which the French workmen are peculiarly skillful.

The French practice has been to carry up the dam in homogeneous layers, not over nine inches thick and rammed to six inches, being watered with lime-water. The *pierre*, or stone pitching of the face, is carried up in independent walls, so that injury to one does not entail the ruin of the rest. The French dispense with the puddle-wall.

The dam across the Schuylkill River at the Fairmount Water-Works, Philadelphia, measures 1,600 feet from bank to bank, forming an angle of about 45° with the direction of the stream. By this extension of length the perpendicular rise above the top of the dam is lessened during high water. The

Fig. 1589.



Overfall Dam across the Schuylkill, Philadelphia.

slack water above the dam extends about six miles, and a canal and locks are provided for overcoming the rise. A part of the bottom consisted of mud, and upon this portion, 270 feet in length, a foundation of rubble was laid, and covered with earth. This portion is 150 feet broad at the base and 12 feet on top, being encased with large stones. The overfall dam is 1,204 feet in length, founded on the bare rock, the deepest portion having a depth of 24 feet below low tides.

While on the subject of dams we must not forget that constructed by Lieutenant-Colonel Bailey to rescue the fleet of gunboats on Red River after the disastrous defeat of the army under General Banks in his ill-starred and worse-managed expedition. As the fleet arrived in the neighborhood of Alexandria it was detained by the low stage of water on the falls at that point. It seemed impossible to escape from the trap, but Colonel Bailey constructed a wing-dam 600 feet in length, which concentrated the flow of water in a narrow channel, and made it possible for the gunboats to float down to the lower level, whence they reached the Mississippi. The operation is termed *flashing*.

2. Of a blast-furnace. See DAM-PLATE; DAM-STONE.

Da-mas'cus-i'ron. Damascus-iron is produced by the following method: —

Unite by welding twenty-five bars of iron and mild steel alternately, each about 2 feet long, 2 inches wide, and ¼ inch thick, and having drawn the fagot into a bar ⅜ inch square, cut it into lengths of 5 or 6 feet. One of these pieces is heated to redness, and one end is held firmly in a vice, while the other is twisted by a wrench or tongs, which shortens the rod to half its length and makes it cylindrical. If two of these twisted pieces are to be welded together, they are turned in diverse directions, one to the right and the other to the left; these are laid parallel to each other, welded and flattened. If three rods be used, the outside ones turn in a direction the opposite of the middle one, and this produces the handsomest figure. By these operations the alternations of iron and steel change places at each half-revolution of the square rod, composed of twenty-five laminæ, the external layers winding round the interior ones; thus forming, when flattened into a ribbon, irregular concentric ovals or circles. The fineness of the Damascus depends upon the number and thickness of the alternations; and the figure of the ribbon, when brought out by acids, resembles that of a curled ostrich feather, but when wound into a spiral form and united on its edge by jumping, the edges bend around, and the figure is completed. Other modes might be mentioned, but all involve the same principles. See WOOTZ.

Da-mas'cus-twist. A kind of gun-barrel made of a ribbon of Damascus-iron coiled around a mandrel and welded. See DAMASCUS-IRON.

Dam'ask. 1. (*Fabric.*) *a.* A rich silk stuff originally made at Damascus and thence deriving its name. It had raised figures in various patterns, and

flowers in their natural colors embossed upon a white or colored ground. The work was probably of the nature of embroidery in the first place, but the figures were afterwards exhibited on the surface by a peculiar arrangement of the loom, which brought up certain of the colors and depressed others, according to the requirements of the pattern.

We read of similar goods in the year 1305 B. C., when Deborah celebrated the victory over Sisera: —

"Divers colors of needlework on both sides, meet for the necks of them that take the spoil."

The events of the bloody battle of Mt. Tabor took place but four days' march from Damascus, and it is probable that this ancient city was, as early as the times of Abraham (1996 – 1822 B. C.), the workshop of articles in metal, silk, wool, and flax, as well as the depot of an extensive trade between the Orientals on the east and the Phœnicians, the carriers of antiquity, on the west.

Abraham's steward was a man of Damascus, and, in default of issue, would have been heir to his property. Through all the uproar of antiquity Damascus has maintained a prominent position, being geographically well situated and rich in the great necessity of a warm climate, water.

"Are not Abana and Pharpar, rivers of Damascus, better than all the waters of Israel?" said the haughty Syrian.

Mohammed refused to enter the city, as it was decreed that a man could enter Paradise but once, and he did not wish to exhaust his chances by an entrance on a paradise upon earth.

The steel, the roses, and the fabrics of Damascus survive in most modern languages.

The rich work of the looms of Damascus opened the eyes of the rugged men of the West, who alternately won and lost the rocky mountain-road which led to Jerusalem, and the fabric has retained its name and substantially its character ever since.

Silk and worsted damasks were favorite materials with our grandmothers for bed-hangings, curtains, and the upholstering of furniture.

"A bed of ancient damask."

b. A woven fabric of linen, extensively made in Scotland and Ireland, and used for table-cloths, fine toweling, napkins, etc. By a particular management of the warp-threads in the loom, figures, fruits, and flowers are exhibited on the surface, as in the ancient damask. It is known as *washing* damask, or, when unbleached, as *brown* damask.

A small patterned toweling, known as *diaper*, has a figure produced in the same manner.

c. Stuff with a wavy or watered appearance. *Moire.*

2. (*Metallurgy.*) A wavy pattern shown in articles forged from a combined iron and steel blank. The two metals are mechanically associated, and the bar is then twisted, doubled, welded, or otherwise treated, so as to convolve the fibers of the respective metals. When the forging and grinding (and tempering if a sword) are completed, the article is dipped in acidulated water, which corrodes the steel and does not affect the iron. The steel waves thus appear black, and the iron remains white.

The *damask* is produced by the unequal tendency to oxidation of the two metals.

It must not, however, be supposed that mere ornamentation is the principal object of the mechanical combination of the metals. The main object is quality of the blade or the barrel, as the case may be, and the figure demonstrates visibly the degree and completeness of the association; not intermixture, as the lines of demarcation are well marked, though the laminæ are indissolubly welded.

If the steel be drawn lengthwise, the veins of the pattern will be longitudinal; if the metal be extended equally in different directions, the veins will be crystalline; if it be made wavy in two directions, there will be various shades and gradations, as in the Oriental damask. The orbicular veins or any other pattern is produced by peculiar turns and manipulations, and depends upon the skill of the workman.

Dam'ask-car'pet. Also known as *British*, a damask Venetian. A variety of carpet resembling the Kidderminster in the mode of weaving, but exposing the *warp* instead of the *weft*.

Dam'ask-een. The name is derived from Damascus, where the art is held to have originated.

It means to ornament one metal by another by inlaying or incrustation, as, for instance, a sword-blade of steel, by figures of gold. The metal to be ornamented is carved or etched, and the hollows or lines filled in with the gold or silver, and united by hammering or by solder. It was practiced as early as 617 B. C. by Glaucus of Chios. The analogous operation of inlaying bronze and stones with gold or silver was practiced at remote periods by the Egyptians, as the statues and scarabæi witness. This mode of decoration of metal is principally applied to the ornamentation of swords and other weapons, and has three forms among the Persians, where the art is principally practiced.

a. The design is drawn by a brush, engraved, wires laid in so as to project, and fastened at points by golden nails. The surface of the gold inlay is then engraved.

b. The engraved blade is filled even to the surface with gold, which is pressed in and polished by a burnisher of nephrite.

c. The design consists of a great number of minute holes, which are filled with gold-wire burnished in.

Dam'ask-loom. A loom for weaving figured fabrics. See JACQUARD.

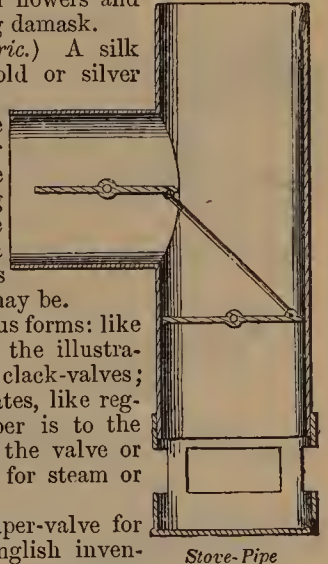
Dam'ask-steel. The steel of Damascus originally; the process traveled into Khorassan and Persia, where it prospered long, but decayed as the hordes swept over the country. It is a laminated metal of pure iron and steel, of peculiar quality, produced by careful heating, laborious forging, doubling, and twisting. See DAMASCUS-IRON.

Da-masse'. (*Fabric.*) A Flanders linen, woven with flowers and figures, and resembling damask.

Dam'as-sin. (*Fabric.*) A silk damask containing gold or silver flowers in the fabric.

Damp'er. 1. A plate in an air-duct, whether air draft or flue, for the purpose of regulating the energy of the fire by regulating the area of the passage of ingress or egress, as the case may be.

Fig. 1590.



Stove-Pipe Damper.

Dampers are of various forms: like butterfly-valves, as in the illustration; hinged flaps, like clack-valves; sliding or rotating grates, like registers, etc. The damper is to the air-pipe or flue what the valve or faucet is to the duct for steam or liquids.

The register or damper-valve for chimneys is an old English invention, and is referred to as such by Savot, in his book, 1624.

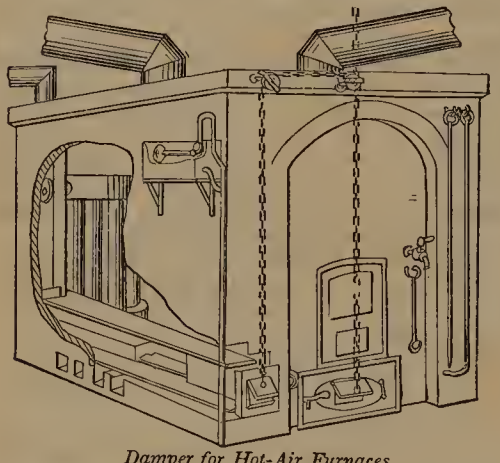
The *Laconicum*, or stove of Laconia, used in heat-

ing the air of the sweating-apartment of the Roman baths, was heated by the flames of the *hypocaustum* beneath the floor. The heat of the stove was regulated by means of a brazen shield suspended by a chain so as to close entirely or partially the opening of communication between the stove and the basement furnace. In the Baths of Titus a globe attached to a chain acted as a ball-valve in the same manner as a *damper*.

The dampers of furnaces are either in the door of the ash-pit, to regulate the ingress of air, or in the course of or on top of the chimney, to close the egress of the volatile results of combustion. In the latter form they are used in almost all metallurgic furnaces.

In Fig. 1591, the furnace-door and flue-door are respectively furnished with dampers, so connected

Fig. 1591.



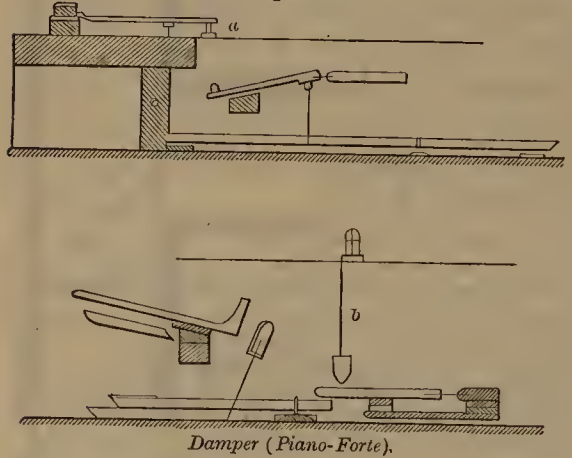
Damper for Hot-Air Furnaces.

that when one is opened the other is closed, and *vice versa*.

2. (*Music.*) A padded finger in a piano movement which comes against the strings and limits the period of the vibrations. Its normal position is upon the string, from whence it is lifted by a wire as the key is depressed by the player.

The damper has assumed various forms: the single action, in which the damper-wire *a* rests on the key;

Fig. 1592.



Damper (Piano-Forte).

the double action, in which the damper-wire *b* rests on a separate lever below.

Bacon says: "In spinets, as soon as the spine is let fall to touch the string, the sound ceases."

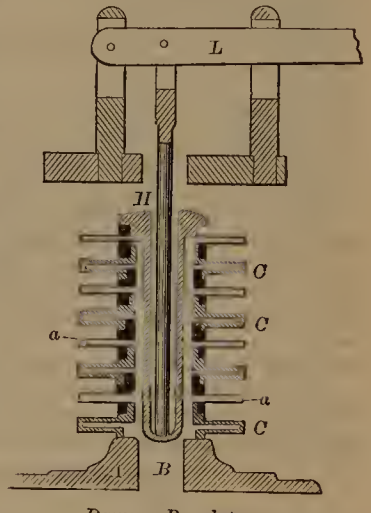
Damp'er-reg'u-la'tor. A device, by which the heat of a furnace or the pressure of steam is made to vary the area of the air-supply opening of the furnace, or of the flue which carries from the furnace the volatile results of combustion.

In the former case the device is thermostatic, usually consisting of a rod or combination of rods, which lengthen or shorten as the heat increases or diminishes above a determinate point; the said variation in length acting mechanically by suitable connections to open or close a damper in the ash-pit door or the flue.

The damper-regulators which act by the pressure of steam are of three or more kinds.

a. A tube is inserted in the top of the boiler, and its open end descends below the water-level. The pressure of the steam supports a column of water in this tube, and the hight of the column varies with the pressure of steam. A float in the tube is supported upon the water; a chain from the float passes over one or more pulleys, and is carried to the damper which is suspended to it. When the pressure of steam is decreased by its withdrawal for the use of the engine or by the slackness of the fire, the column of water descends, bearing the float with it. The float draws upon the chain and raises the damper, so as to allow a greater draft and urge the fire.

Fig. 1593.



Damper-Regulator.

b. A device acting by the direct pressure of steam against a piston or diaphragm, to actuate a lever which will open or close the draft as a greater or less amount of heat is required. The base *A* is fitted on the boiler, and the steam through *B* acts within the expansible hollow disks *C a* to raise the rod *H*, which lifts the lever *L*, or, when the pressure slacks, by the collapse of the disks to let the lever fall.

c. An electro-magnetic device in which a column of mercury is lifted by the pressure of steam, and when above or below its normal or determinate level closes a circuit and brings into action an armature which opens or closes the furnace-door.

Damp'ing-ma-chine'. 1. (*Printing.*) A machine for damping sheets of paper previous to printing. A certain amount of the paper may be thoroughly wetted and built up between dry quires into a pile, by their own weight or pressure causing an equal distribution; or a quire may be quickly passed under water and out again and then built up with others into a pile; or a sparger may be used, as in the perfecting presses which print from a roll, which sends a fine spray upon the paper as it is rolled off from one rod and rolled on to another.

2. A machine in which starched goods are moistened previous to running them through the calendering-machine, to give them a finished and lustrous surface.

Dam-plate. A plate in front of the *dam-stone* which forms the bottom of the hearth in a blast-furnace. See BLAST-FURNACE.

Fig. 1594.

Dumping-Machine.

Dam'sel. A projection on a mill-stone spindle for shaking the shoe.

Dam-stone. The stone at the bottom of the *hearth* of a blast-furnace. See BLAST-FURNACE.

Dan. (*Mining.*) A truck or sled used in coal-mines.

Da'na-ide. A water-wheel having a vertical axis and inner and outer drums between which radial floats are attached. The water acts tangentially upon the spirally arranged radial floats, passes down between the said inner and outer cases, and is discharged at the bottom. The water dashes upon the wheel from a chute, and, the floats being spiral, the wheel may be said to act by percussion and recoil. A *tub-wheel.*

Dan'dy. 1. (*Nautical.*) A sloop or cutter with a jigger-mast abaft, on which a mizzen lug-sail is set.

2. (*Paper-making.*) A perforated roller employed to press out the surplus water and *set* the paper. Patented in England by Wilks, in 1830. A partial vacuum is obtained in that part of the roller on which the paper rests.

Dan'dy-brush. A hard, whalebone-bristle brush.

Dan'dy-horse. A velocipede.

Dan'dy-rig Cutter. A peculiarly rigged sloop. See DANDY.

Dan'dy-roll'er. (*Paper.*) A sieve-roller beneath which the web of paper-pulp passes, and by which it is compacted and partially drained of its water. It may be made the means for *water-marking* the paper. The paper passes thence to the first pair of pressing-rollers. A *dandy.*

Dan'iell's Bat'ter-y. The double-fluid battery invented by John Frederick Daniell, F. R. S., who received the Copley medal from the Royal Society in 1837 for this invention; he died in 1845.

A jar of glass or earthenware, in which fits a plate of copper bent into cylindrical form. Within the copper is a porous cup containing the zinc. The liquids used are a saturated solution of sulphate of copper in the outer cell, and of sulphuric acid in the inner cell or porous cup.

To the copper a perforated shelf or jacket is often attached for holding crystals of sulphate of copper, so that the solution may be kept at the point of saturation. See GALVANIC BATTERY.

Dan'ish Bal'ance. A form of the steelyard, the inverse of the Roman or Chinese. The weight and load are suspended at the respective ends, and the suspension-loop is shifted along the beam till equilibrium is attained. The weight of the goods is thus to the weight of the *bob* reciprocally as their respective distance from the loop. (See Fig. 530.)

Dar'by. (*Plastering.*) A float-tool used by plasterers in working on ceilings especially. It is 3½ feet long and 7 inches wide, with two handles on the back by which it is manipulated.

Dark-box. A closed chamber in which an electric light is placed in order that experiments may be deprived of all light except the beams issuing at the lens. See ELECTRIC LIGHT.

Dark-glass'es. Shades fitted to optical reflecting-instruments to intercept the sun's rays.

Dark-lan'tern. A lantern having a circular shade which may be used to close the aperture and hide the light. (See Fig. 972.)

"My father and I with a dark lanthorn, it being now night." — PEPYS'S *Diary*, 1667.

Dark-slide. (*Photography.*) The holder for the sensitized plate. See PLATE-HOLDER.

Dark-well. A cell elevated beneath a transparent object in a microscope, to form an opaque background when the said object is to be viewed as illuminated by light from above.

Darn'ing-last. A potato, an egg, an apple, or a small gourd, to stretch a portion of a stocking while being darned.

Darn'ing-nee'dle. One of large size for carrying a woolen yarn in stopping holes in knitted or woven fabrics.

Dart. A missile spear or javelin much in use among the ancients, and yet seen among many of the more barbarous nations. The Caffres of South Africa and the aboriginal inhabitants of Australia are very expert in the use of the *assegai.* The darts in use among the ancients were of two kinds, namely, spear-headed (that is, without barbs), or bearded. The former were often attached to a long cord, enabling the thrower to recover his weapon after having thrown it. Dart-heads are usually made of iron, but among savage nations flints, sea-shells, fish-bones, and other hard substances, have been employed; and among some of the aboriginal inhabitants of Africa and America the dart was merely a sharp-pointed stick, the end of which was carbonized by fire. The weapon is always very simple in its construction, and is usually from 3 to 5 feet long.

Dash. 1. (*Printing.*) A short line (—) occurring in a sentence to mark a significant pause of more moment than that indicated by a comma.

Also used to indicate a consecutive series, as, John xiv. 1 – 8. Also used as a "ditto" mark.

The *em-dash* is the length of the "em" of its font; the *en-dash* one half the former. The *double-dash* has the length of two em's.

2. (*Vehicle.*) Formerly *splash-board.* A board or fender erected on the forepart of the bed, and standing in front of the driver. A *dash-board.*

Dash-board. 1. The float of a paddle-wheel.

2. The splash-board of a vehicle.

Dash-pot. A contrivance for easing the fall of a weight. The falling-rod is connected to the piston, and the latter plunges into the water contained in the cylinder. See CUT-OFF (Fig. 1571).

Dash-rule. (*Printing.*) A rule between articles across a column or page, and shorter than the width-measure.

Dash-wheel. (*Bleaching.*) A wheel with compartment revolving partially in a cistern, to wash

and rinse calico in the piece, by alternately dipping it in the water and then dashing it from side to side of the compartments as the wheel rotates.

Da-sym'e-ter. An instrument for weighing gases. It consists of a thin glass globe, which is weighed in the gas and then in an atmosphere of known density.

Da'tum-line. (*Engineering.*) The horizontal line of a section from which all hights and depths are calculated.

Daub'ing. 1. (*Currying.*) Or *dubbing.* A mixture of fish-oil and tallow which is worked into leather after the latter has been shaved by the knife at the currier's beam.

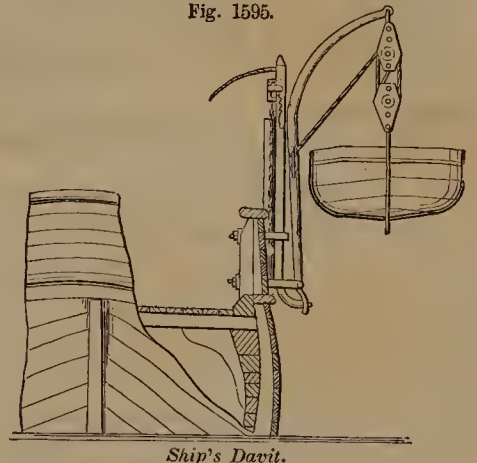
2. (*Plastering.*) *a.* A rough coat of mortar thrown upon a wall, and supposed to give it the appearance of stone. *Rough-cast.*

b. The *chinking* or closing of the apertures between the logs of a cabin. The *daubing* is usually mud. The chimneys, made of sticks, are also *daubed* inside and out.

Dav'it. (*Nautical.*) *a.* A beam projecting from a ship's bow, for the attachment of the tackle whereby the anchor-fluke is lifted without dragging against the side of the vessel. The operation is termed *fishing the anchor.*

b. One of a pair of cranes on the gunwale of a ship, from which are suspended the *quarter* or other

Fig. 1595.



Ship's Davit.

boats. The boat-tackles are attached to rings in the bow and stern of the boat respectively, and the fall is belayed on deck. When the boat is lowered the hooks of the fall-blocks are cast off simultaneously, or great danger results, when the ship is under way. See BOAT-LOWERING APPARATUS, p. 314.

Dav'it-fall Hook. A hook having a means for instant unclutching or release, and used at the end of a davit-fall to engage a ring-bolt at the stem or stern of a boat. See BOAT-DETACHING APPARATUS; DAVIT.

Fig. 1597.

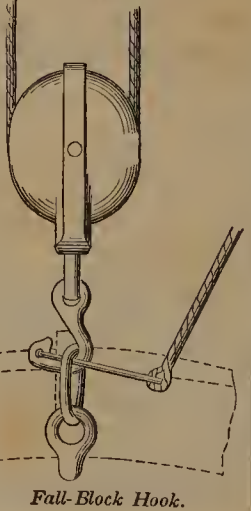


Fig. 1596.

Davit-Fall Hook. *Fall-Block Hook.*

In Fig. 1596, the hooked ends are kept together by the suspending-chain, and are opened by their weighted arms as the boat touches the water.

In Fig. 1597, the hook is capsized by a lever and a cord.

Da'vy-lamp. (*Mining.*) The safety-lamp of Sir Humphry Davy, in which a wire-gauze envelope covers the flame-chamber and prevents the passage of flame outward to the explosive atmosphere of the mine, while it allows circulation of air. See SAFETY-LAMP.

Day. The light of a window in a bay; the distance between mullions.

Day-lev'el. (*Mining.*) An *adit,* or *sough.* A drift whose outer end is at the natural surface, open to the day.

D-block. (*Nautical.*) A block bolted to the ship's side in the channels, to reeve the lifts through.

Dead. 1. *Lusterless;* as of some kinds of unpolished or unburnished metallic surfaces. *Matt.* Also of color without brilliancy, as *dead* color. *Destemper.*

2. *False;* as of imitation doors and windows, put in as architectural devices to balance parts.

3. *Motionless;* as the *dead* spindle of a lathe, which does not rotate. A *dead*-lock. *Dead-center* of a crank.

4. *Opaque;* as a *dead*-light or shutter over a cabin window.

5. *Solid, without light or opening;* as a *dead-wall,* a *dead-plate,* or unperforated portion of a furnace-grate; the *dead-wood* of a ship.

6. *Useless;* as *dead steam,* that is, exhausted. *Dead-head,* a *feeding-head* or *sullage-piece. Dead-weight. Deads* in mining, the useless substances which enclose the ore.

7. *Soundless;* as a *dead-floor,* which absorbs the sound.

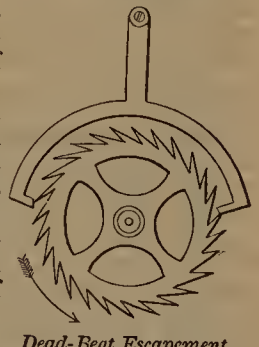
8. *Flat;* as a *dead-smooth* file; having the least possible hight of teeth. *Dead-level.*

Dead-an'gle. (*Fortification.*) The space in front of a parapet which is out of view of the soldiers in the work, and which they cannot fire upon.

Dead-ax'le. An axle which runs, but does not communicate motion, as distinguished from a *driving*-axle, which is a *live*-axle.

Dead-beat Es-cape'ment. This, which is also known as the *escapement of repose,* was invented by Graham about 1700, and was intended to isolate the going works more completely from the pendulum. The seconds-hand in the *dead-beat* stands still after each drop, whereas in the *recoil-escapement* there is a *back-lash* to the train.

Fig. 1598.



Dead-Beat Escapement.

The working surfaces of the *pallets* of the *anchor* in this escapement are curved concentrically with the axis of oscillation of the anchor. When a pallet escapes from one tooth and allows a partial rotation of the *scape*-wheel, a tooth on the opposite side is arrested by the other pallet, but without giving any back-lash to the wheel, which would cause a recoil to the train of gearing.

The term *dead-beat* is to contradistinguish it from the *recoil*-escapement (see Fig. 193), in which the working faces are curved eccentrically in relation to their axis of oscillation so as to offer a slight impediment to the motion of the wheel. This impediment

causes a slight *recoil* of the *scape-wheel*, which is communicated to the *train*. The pallets in the *recoil*-escapement are both *check* and *impulse*, but in the *dead-beat* one is simply *check* and the other gives a slight *impulse* at the moment of escaping. The impulse given to the pallet is communicated to the pendulum, to overcome the friction on the pendulum bearing and the resistance of the air, and thereby keep the beats of the pendulum isochronous. The *cylinder* or *horizontal* escapement is a *dead-beat* escapement for watches, and was also invented by Graham.

Dead-cen'ter. One of the two points in the orbit of a crank in which it is in line with the connecting-rod. The *dead-point*.

Dead-col'or-ing. (*Painting.*) A first layer of color forming a basis for that which succeeds it. It is called *dead* because it has no gloss, and is to be hidden by the finishing coats. *Destemper*.

Dead-door. (*Shipbuilding.*) One fitted in exterior rabbets, to protect a cabin window or cover an opening when the lights are carried away.

Dead'en-ing. 1. (*Carpentry.*) Packing in a floor, ceiling, or wall, to prevent conduction of sound. Such provision constitutes it a *dead-floor*, or *dead-wall*. *Pugging*.

2. (*Gilding.*) A thin coat of glue, slightly warmed, smeared over a surface that is gilded in destemper, and is not to be burnished.

3. Roughening a surface to diminish the glitter.

Dead-eye. (*Nautical.*) *a*. A block without a sheave, probably so named from a grotesque resemblance to a death's-head or skull. Such are those flat, round blocks fixed in the channels, and having eyes for the lanyards by which the shrouds are set up. The circumferential groove for the shroud is called the *score*. The *dead-eye* is also known as a *ram-block*.

Fig. 1599.

Dead-Eye.

b. The *crow-feet dead-eyes* are cylinders with a number of holes for the lines composing the crow's-foot. A *euphroe* or *uvrow*.

c. The eye-bolt or staple on the gunwale of a canal-boat to which the towing-line is bent. The line is retained by a key of wood, which passes through the eye and is cast loose by pulling out or breaking the key.

Dead-fall. (*Machinery.*) 1. A dumping-platform at the mouth of a mine.

2. A trap in which a falling gate, board, or log drops upon the game and kills it. Used especially for vermin.

Dead-file. One whose cuts are so fine and close that its operations are practically noiseless. See DEAD-SMOOTH FILE.

Dead-flat. The midship bend or frame having the greatest breadth.

Dead-flue. One which is bricked up at bottom and discontinued.

Dead-gold. The unburnished surface of gold or gold-leaf, from the electro bath or the hands of the gilder. Parts of objects are frequently left unburnished as a foil to the brilliant and lustrous burnished portions. Gilders call it *matt*. See GILDING.

Dead-ground. (*Mining.*) A body of non-metalliferous rock dividing a vein, which passes on each side of it. The vein is said to *take horse*, in allusion to its straddling the intervening rock.

Dead-head. 1. (*Ordnance.*) An extra length of metal cast on the muzzle end of a gun in order to contain the dross and porous metal which floats on the sounder metal beneath. When cooled and solid the *dead-head* is cut off.

2. (*Founding.*) That piece on a casting which fills the ingate at which the metal entered the mold. A *feeding-head* or *sullage-piece*.

3. (*Lathe.*) The tail-stock of a lathe containing the *dead-spindle* and *back-center*; in contradistinction to the *live-head* or *head-stock* at the other end of the *sheers*, which contains the *live-spindle*.

4. (*Nautical.*) A block of wood used as an anchor-buoy.

Dead'ing. (*Steam-engine.*) The clothing or jacket around a steam boiler or cylinder to prevent radiation of heat. *Cleading; lagging*.

Dead-latch. A kind of latch whose bolt may be so locked by a detent that it cannot be opened from the inside by the handle or from the outside by the latch-key. The detent is usually capable of locking the bolt in or out, so that the device forms a latch, a dead-lock, or is made inoperative, as desired.

Dead-let'ter. (*Printing.*) Type which has been used for printing, and is ready for distribution. *Dead matter*.

Dead-light. (*Nautical.*) A shutter placed over a cabin window in stormy weather, to defend the glass against the blows of the waves.

Dead-lock. (*Locksmithing.*) A lock operated on one side by a handle and on the other side by a key.

Dead Met'al. Metal, such as gold or silver, left with dead or lusterless, that is, unburnished or unpolished, surface. *Matt*.

Dead-plate. (*Furnace.*) An ungrated portion of a furnace floor, on which coal is *coked* previously to pushing into the fire above the grates. It was introduced by Watt in his patent of 1785.

Dead-point. One of the points at which the crank assumes a position in line with the pitman or the rod which impels it. In steam-engines with vertical cylinders, the *dead-points* are the highest and lowest positions of the crank. A *dead-center*.

Dead-ris'ing. The portion of the ship's bottom formed by the floor timbers.

Deads. (*Mining.*) Non-metalliferous rock excavated around a vein or in forming drifts, levels, shafts, cross-courses, etc. Many veins are too narrow for working, and the walls have then to be cut into to afford space. Such work, as yielding nothing, is called *dead-work* or *tut-work*, and the proceeds are *deads* or *attle*, to be got rid of as economically as possible, by sending up to the surface, or filling up the *gunnies* and *goafs* of old workings.

Dead-sheave. (*Nautical.*) A scored channel for the run of a rope; destitute of a sheave.

Dead-shore. A timber strut worked up in brick-work to support a superincumbent mass, till the brick-work which is to carry it has set or become hard.

Dead-smooth File. A file whose teeth are of the finest and closest quality. The grades are as follows:—

Rough.	Second-cut.
Middle-cut.	Smooth.
Bastard.	Dead-smooth.

The number of the teeth to the inch of a *dead-smooth* file varies with its length in inches.

Inches .	4	6	8	12	16	20
Cuts .	216	144	112	88	76	64

The angle of the chisel in cutting is about 4° from the perpendicular.

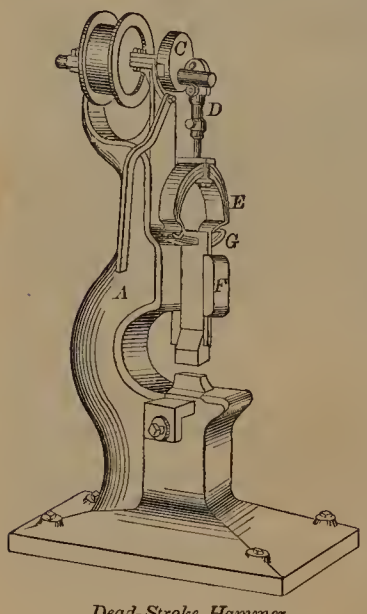
Dead-spin'dle. (*Lathe.*) The non-rotating spindle in the *tail-stock* or *dead-head* of a lathe.

Dead-steam. Steam destitute of energy, inactive from want of heat, from having attained its

ultimate expansion, or from being so placed as to have no effective value in any given case.

Dead-stroke Ham'mer. A power-hammer which delivers its blow without being affected by the recoil of the shaft on which the ram or hammer is stocked. The frame *A* has a crank-wheel *C* connected by a rod *D* to the spring *E*, from which the hammer is suspended. The latter moves in guides *F*.

Fig. 1600.



Dead-Stroke Hammer.

Dead-wall. A wall unrelieved by windows or other openings.

Dead-weight. The weight of the vehicle of any kind; that which must be transported in addition to the *load*. The extent of dead-weight in railway traffic may be judged from the following estimate: —

	Pounds.
Weight of locomotive and tender . .	104,000
One baggage-car	25,000
Three 56-seat passenger-cars . . .	84,000
One sleeping-car	40,000
	253,000

These cars, if filled, will carry about 194 passengers, which will give 1,304 pounds of dead-weight for each person carried.

Dead-well. A well dug through a stratum impervious to water and penetrating a porous strata; used to allow surface-water to pass away, or to carry off by infiltration refuse water of factories, dye-houses, etc. An *absorbing*-well. See DRAIN-WELL.

Dead-wood. (*Shipbuilding.*) The solid mass of built-up timbers at the narrow portions of the extremities of a ship's frame, fore and aft, above the keel, and continued as high as the *cutting-down-line*. In arctic vessels the *dead-wood* is in unusual quantity, to give solidity to a structure liable to contact with ice-floes and drifts.

Dead-works. The parts of a vessel above the load water-line.

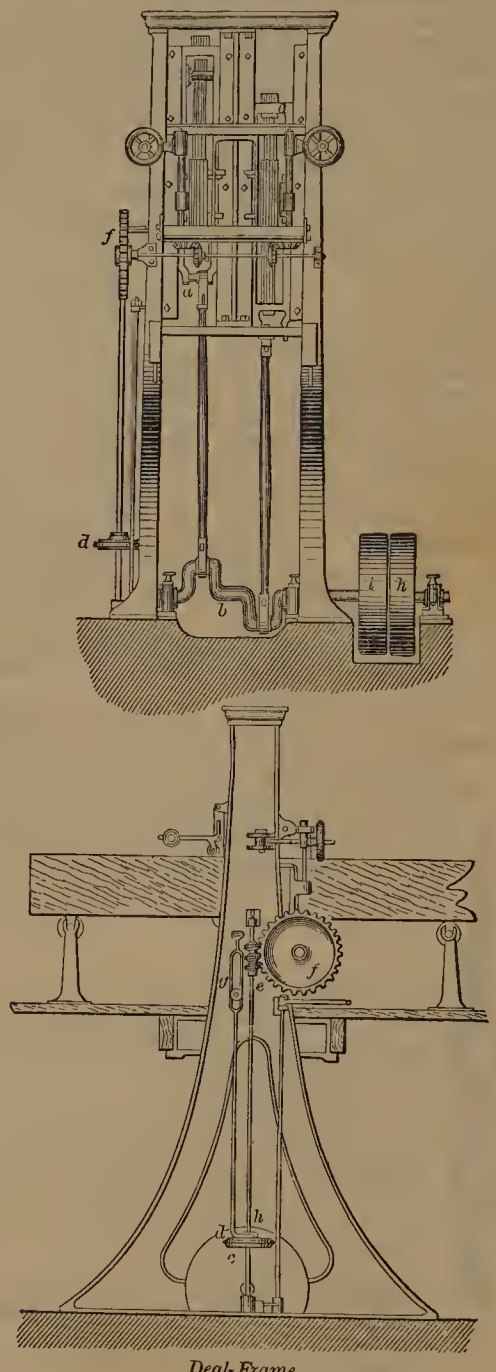
Deal. A plank 12 feet long, 11 inches wide, and 2½ inches thick. Deals are sawed of other sizes, but are reduced to that cubic dimension in computing them.

Practice may differ in different countries. The above is the Ottawa rule. In England, lumber not exceeding 3 inches in thickness and 9 inches wide.

Deal-frame. A *gang-saw* for slitting deals or balks of pine-timber.

The illustration shows the English form of the machine, which has two separate saw-gates *a a*, worked from diametrically opposite cranks on one shaft *b*. The feed is continuous, and the rate of advance adjustable from 18 inches to 72 inches per minute. The feed-motion is by a friction-disk *c*, rod *h*, worm *e*, and wheel *f*, and the rate is adjusted

Fig. 1601.



Deal-Frame.

by a lever which raises or lowers the friction-wheel *d* on the disk.

Dean. (*Mining.*) The end of a level or gallery.

Dear'born. A light four-wheeled family carriage of moderate pretensions and named after the designer.

De-bage'. (*Fabric.*) A dress-goods like alpaca, having a cotton warp and a woolen filling, which is dyed in the wool and mixed in the thread.

De-blai'. (*Fortification.*) The excavated earth which forms the *remblai* or elevated work.

De-bran'ning-ma-chine'. A machine or process for decorticating grain. It is accomplished by steaming and rubbing, by a partial grinding, or by a process equivalent to rasping. See DECORTICATOR.

De'bus-cope. A modification of the kaleidoscope, invented by M. Debus, a French optician.

It consists of two highly polished silvered plates, set at an angle of 70° with each other. When placed before a picture or design, an assemblage of flower petals, or other small colored objects, beautiful designs are formed by their reflected images. The instrument is held stationary while these are copied, and by successively moving it over the object, different combinations of figures are shown, which may be added to the first. It is particularly intended for the use of draftsmen who are required to design ornamental patterns for fabrics.

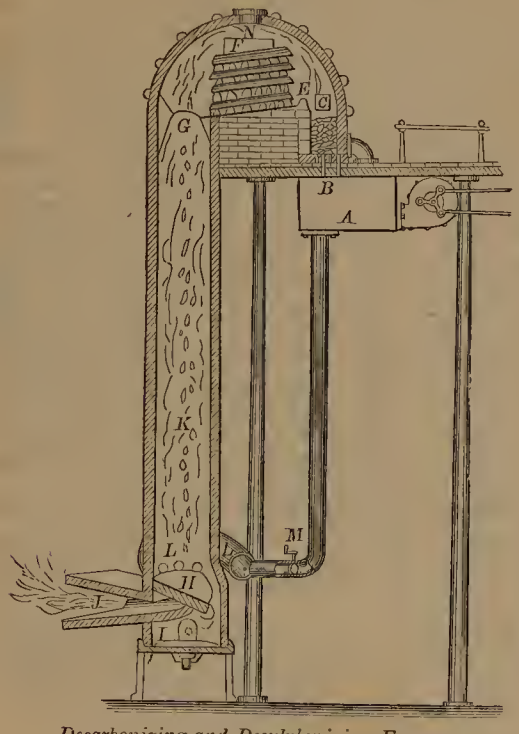
Dec'a-chord'on. An ancient form of harp having ten strings.

De-can-ta'tion. The pouring of a clear liquid from the sediment. In starch-making and operations on a similar scale it is performed by siphons.

De-car'bon-iz'ing-fur'nace. A furnace in which superfluous carbon is burned out of a metal. The term is a very general one, and may include the boiling and puddling furnaces in which cast-iron is heated to make the metal malleable.

Fig. 1602 shows a decarbonizing and desulphurizing furnace in which the air from the blast-wheel is conducted by chamber *A* and tuyeres *B* to the fuel-chamber, whence the flame proceeds to the dome *N*,

Fig. 1602.



Decarbonizing and Desulphurizing Furnace.

and acts upon the pig-iron *F*, which is piled upon the hearth *E*. As the iron melts it runs through the throat *G*, and falls down the shaft *K*, upon the platform *H*, where it rebounds in fine particles, and is exposed to the air from the blast-pipe *L* and its tuyeres, collecting in the hearth *I*. *N* is the charging-hole ; *M*, damper ; *J*, exit-flue.

Deck. (*Shipbuilding.*) A floor in a ship above the bottom of the hold. Boats have no permanent decks, but are sometimes temporarily covered with a *preventer-deck*.

The deck is said to have been a Thasian invention ; first, as a protection to the rowers beneath. In its primary form it was a scaffold, one at the prow and another at the stern, for the combatants.

Decks may run from stem to stern, or be but partial. Some fishing-craft have a partial deck forming a cuddy.

Vessels are classed, for some purposes, by the number of their decks ; as, *single-decked*, *two-decked*, *three-decked*.

In three-decked ships the decks above the water-line are known as the *upper* or *spar*, *main*, *middle*, *gun* or *lower* deck. In two-decked ships, the *upper* or *spar*, *main*, and *gun* deck.

In frigates and merchant-vessels, the upper and main decks.

The deck next below the water-line is the *orlop*-deck in two or three deckers, but is known as the lower deck in vessels of the lower grades. The after-part of the *orlop-deck* is the *cock-pit*.

A passage round the *orlop*-deck, to get at the ship's side for repairs during action, is called the *wing-passage*. On this deck are the cabins and berths of officers and men.

A complete deck over the main-deck is the *spar* or *flush* deck.

The *forecastle* is the foremost part, and the *quarter-deck* the aftermost part, of the *spar*-deck ; the *waist* is the space amidships.

A small deck at the after end is the *poop* or *round-house*, and usually extends to the mizzen. Above it is the *poop-deck*.

A similar deck at the forward end is called the *topgallant-forecastle*.

A transverse deck extending across the middle of the vessel is called a *hurricane*-deck, *bridge*-deck, or bridge. It is common in steam-vessels, covering the space between the paddle-boxes.

Detached buildings on a deck are *deck-houses*.

The openings in a deck are *ladder-ways* or *hatch-ways*. *'Tween-decks* is the space below the *spar-deck*.

The former is by a hood or covering called a *companion*. The coverings of a *hatchway* are *hatches*.

The raised ledges around the hatchway are *coamings* in the fore and aft direction ; *head-ledges* in the parts athwartships.

Glasses inserted in holes made in a deck are called *deck-lights*, and serve to light cabins below.

Deck-bridge. 1. One in which the track occupies the upper stringer, as distinguished from one in which the track, whether for cars or carriages, rests on the lower stringer and forms a *through* bridge.

2. A platform connecting the paddle-boxes of a side-wheel steamer, or above and across the deck amidships of a propeller.

Deck'el. (*Paper-making.*) A curb, which by confining the pulp determines the width of the sheet or roll of paper. In hand-machines it is a loose rectangular frame of wood.

In machine work it is continuous ; usually of linen and caoutchouc along the two margins of the apron. The uncut edge of paper is known as the *deckel* edge.

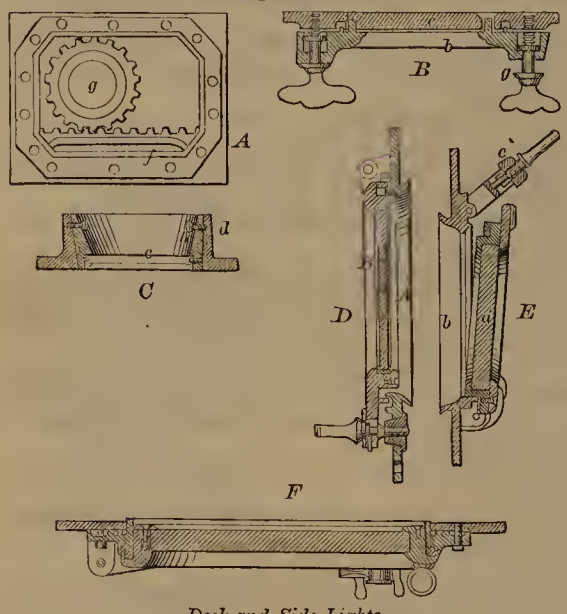
Deck-feed Pump. (*Nautical.*) A hand-pump used for washing decks, feeding the boiler, etc.

Deck-hook. (*Shipbuilding.*) A thwartship-frame crossing the apron in a nearly horizontal position, to strengthen the bow and support the forward end of the deck. See Stem.

Deck-light. A bull's-eye or thick glass window let into an upper deck to light a cabin or stateroom. *Side*-lights are made in a similar manner, and light the staterooms through windows in the side of the vessel.

A has a bull's-eye *g* and a screw-ring which is forced into an elastic packing in the face of the glass, whose frame is rotated by rack *f* as it moves to and from the opening.

Fig. 1603.



Deck and Side Lights.

B, a light *c* is held in a frame *b*, which is secured to the post by screws *g*.

C has a light *c* in a bushing *b*, secured in the post-frame *d*.

D has a frame *B* hinged to frame *A*, and secured by a screw.

In *E* the light frame *a* is secured to *b* by hinges and a swinging arm *c*.

F is secured in a somewhat similar manner.

Deck-nail. A diamond-shaped spike for nailing down the deck-planks.

Deck-plate. (*Steam-engine.*) A plate around the chimney of a marine-engine furnace, to keep the same from contact with the wood of the deck.

Deck-stop'per. A cable-stopper on deck, to secure the cable forward of the windlass while it is being overhauled; or one abaft the bitts to keep more cable from running out.

Deck-tran'som. (*Shipbuilding.*) A horizontal timber under a ship's counter.

Dec'li-na'tion. (*Compass.*) The horizontal angle which a needle makes with the meridian. *Variation.*

Dec'li-na'tor. An instrument used in dialing, for taking the declination and inclination of a plane.

De-clin'ing-di'al. One which cuts either the plane of the prime vertical circle or plane of the horizon obliquely.

Dec'li-nom'e-ter. An apparatus for measuring the declination of the magnetic needle; its variation from the true meridian.

De-coc'tion. An aqueous solution of the active principles of any substance, obtained by boiling.

De-clor-im'e-ter. A measurer of the effects of bleaching-powder.

An instrument to test the power of charcoal in its divided state in decolorizing solutions. It is a graduated tube charged with a test solution of indigo or molasses.

De-col'or-ing-style. A method of calico-printing in which the piece of goods is colored, and a part of it — forming a given pattern — is subsequently discharged. Also known as the *discharge-style*. It may be done by printing a dyed piece with something which cancels a portion of the color, or by printing an uncolored piece with a substance which keeps the color from penetrating certain parts. This is called the *resist-style*. By printing certain parts with a mordant, then coloring, a subsequent washing may remove all trace of dye except at the mordanted parts. See CALICO-PRINTING.

De-cor'ti-ca'tor. A process or a machine for removing the hull from grain. In the hominy-mill the fibrous envelope is taken from the corn, which may be left nearly intact otherwise, if desired. The process is sometimes performed by a preliminary steaming, followed by rubbing or rasping. Decorticating was practiced by the Romans, the whole grain being pounded in mortars with some abradant which rasped off the cuticle or bran. Mills for decorticating are known in England as barley-mills, that grain being principally used as human food in the condition known as *pearl* barley. The barley-mill has a roughened exterior, and revolves in a wooden casing. The middle portion of the latter is lined with sheet-iron pierced like a grater with holes, the sharp edges of which turn upward. In Germany grain is decorticated between stones set at such a distance apart as to rasp the bran off the grain without mashing the latter.

Corn is sometimes decorticated by steeping in lye of wood ashes. The *whole* hominy thus obtained is then repeatedly washed to extricate the potash.

A Prussian process is a modification of the centrifugal machine, in which the bran is removed by friction of its kernels irrespective of any artificially prepared abrading surfaces. A vertical casing has a number of horizontal annular shelves, arranged concentrically with an internal cylindrical drum. This latter has radial vanes, which sweep in the spaces between the shelves. A portion of the casing is made of sheet-metal, and perforated in such manner that currents of air, induced in the operation of the machine, pass out from the casing and thence into a dust or bran chamber, and carry with them the dust and bran as fast as they are liberated from the grain. The grain being placed upon the shelves, the rotation of the drum causes its vanes to carry the grain around at the rate of about three thousand feet per minute. The time required to wholly remove the useless envelopes from the kernels is very short, only from three to four minutes, and by ventilating-passages any undue heating is prevented.

De'cus-so'ri-um. An instrument for depressing the *dura mater* after trephining. — THOMAS.

Deeps. (*Nautical.*) The estimated fathoms between the *marks* on the hand lead-line. See MARKS AND DEEPS.

Deep-sea Line. (*Nautical.*) *a*. A water-laid line of 200 fathoms, and used with a 28-pound weight in sounding. It is usually marked as follows in the British service: —

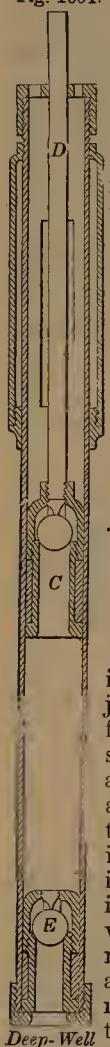
2 and 3 fathoms,		black leather.
5 fathoms,		white bunting.
7	"	red bunting.
10	"	leather with a perforation.
13	"	black leather.
15	"	white bunting.
17	"	red bunting.
20	"	two knots.
30	"	three knots.
40	"	four knots, etc.

A single knot marks the intermediate five fathoms over twenty fathoms.

b. A line for deep-sea fishing. A *cod*-line.

Deep-well Pump. A pump specifically adapted for oil and brine wells which are bored of small diameters and to great depths. From the necessities of the case, the working parts must be contained within a single tube, which has the lower valves

Fig. 1604.

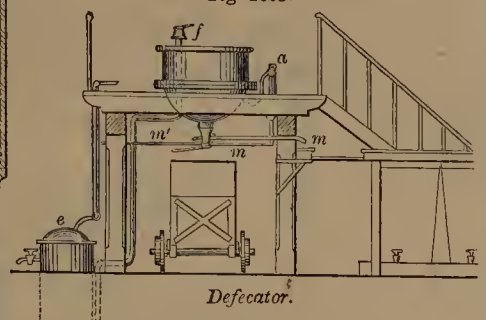


Deep-Well Pump.

and generally a strainer at the foot. Such wells are sometimes 800 feet deep; the tube is in sections united by screw-couplings; the lower end has the foot-valve *E*; the valved bucket *C* is on the end of the long rod *D*, by which the liquid is lifted.

Def'e-ca'tor. (*Sugar-manufacture.*) An apparatus for the removal from a saccharine liquid of the immature and feculent matters which would impair the concentrated result.

Fig 1605.



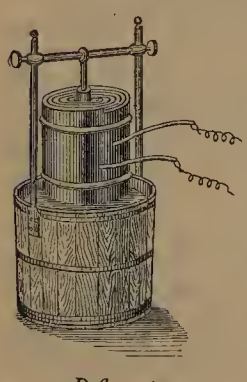
Defecator.

The pans are arranged in rows in the sugar-house and heated by steam-jackets. Their use is to clarify the juice from the mill or the partially concentrated syrup from the first vacuum-pan, the acidity in the liquid being neutralized by a portion of lime. A frothy scum rises to the surface, which increases as the liquid is kept in a simmering condition. In the illustration, *f* is the defecator. The juice is received through a pipe from the reservoir *e*, steam from the boilers being admitted by the tube *a*. The scum having attained a considerable solidity, the liquid is withdrawn by turning the handle *m'* of the faucet, allowing the liquid to pass by the pipe *m m* to the trough, which conducts the clarified juice to another reservoir or to the filters.

In other forms, the juice is exposed in a shower to the fumes of sulphurous acid gas, which tends to arrest the fermentation incident to the presence of nitrogeneous matters in the juice. Defecators for sorghum partake of the character of filters, the action being principally mechanical in arresting the floating matters that render the liquid turbid.

De-file'ment. (*Fortification.*) The arrangement of a fortification in regard to the hight of its parapet and direction of its faces, so as to secure it from an enfilading or reverse fire.

Fig. 1606



Deflagrator.

Defla-gra'tion. The sudden combustion of a substance for the purpose of producing some change in its composition by the joint action of heat and oxygen. It is usually performed by projecting in a red-hot crucible, in small portions at a time, a mixture of about equal parts of the body to be oxidized, and nitrate or chlorate of potash or other energetic oxydizer.

Def'la-gra'tor. An instrument for producing intense heat. It is generally a form of the voltaic battery. Such was used by Davy in 1807–8, when he decomposed soda, potash, borax, and lime.

In the form invented by Dr. Hare of Philadelphia, it is composed of a single sheet each of copper and zinc rolled helically upon a central cylinder of wood. The two metals are prevented from touching each other by intervening pieces of cloth or twine. It is dipped in a tub of acidulated water, and derives its name from its powerful heating effects.

De'flec-tom'e-ter. An instrument for measuring the deflection of a rail by a weight in rapid motion.

De-flect'or. A plate, diaphragm, or cone in a lamp, furnace, or stove, to bring the flame and gases into intimate contact and improve the combustion.

Deg'ging-ma-chine'. (*Cotton.*) One for damping the fabric in the process of calendering.

Dek'le. A curb which determines the margin of the sheet of pulp in hand-made paper.

A strip, sometimes of caoutchouc, lying on the edge of the traveling cloth in a Fourdrinier machine, and forming the edge of the sheet. A *deckle.*

De-laine'. (*Fabric.*) A lady's dress-goods with a cotton chain, woolen filling, untwilled. It is dyed, figured in the loom, or printed.

All-wool delaines are similar, excepting that the chain is of wool.

"The Gauls have a coarse, long-wooled sheep, from which they weave the thick saga called *laines.*"

De'le. (*Printing.*) The expunging term of the proof-reader, marked on the margin.

Delft-blue. (*Calico-printing.*) A mode of printing, also known as *China blue.* See CALICO-PRINTING.

Delft-ware. A kind of pottery originally manufactured at Delft, in Holland, in the fourteenth century. It is now considered coarse, but was among the best of its day, being considered equal to the Italian in quality, but somewhat inferior in its ornamentation.

The glaze of the Delft-ware is made as follows: Kelp and Woolwich sand are calcined together, to form a vitreous mass called *frit.* Lead and tin are calcined to form a gray, powdery oxide. The frit is powdered and mixed with the oxide, zaffre being added to confer blue color, arsenic for dead-white. This is fused, making an opaque enamel; ground and mixed to the consistence of cream.

Delft-ware is made of a calcareous clay of varying color, which is ground in water, strained, and evaporated to a plastic consistence; it is then tempered, and stored in cellars to ripen. Prolonged storage increases its tenacity and plasticity. It is then kneaded, without sand; formed on the wheel, dried, and partially burned, reaching the *biscuit* condition. The bibulous ware is then glazed, dried, packed in *saggars*, which are piled in the kiln and baked.

De-lin'e-a'tor. 1. (*Tailoring.*) A pattern formed by rule; being expansible in the directions where the sizes vary, as indicated by the varying lengths obtained by measurement.

2. (*Surveying.*) A perambulator, or geodetical instrument on wheels, with registering devices for recording distances between points; a pendulum arrangement by which a profile line is inscribed on a traveling strip; and certain other data, according to construction.

De-liv'er-ing-roll. See DELIVERY-ROLLER.

De-liv'e-ry. (*Founding.*) The draft or allowance by which a pattern is made to free itself from close lateral contact with the sand of the mold as it is lifted. Also called *draw-taper.*

De-liv'er-y-roll'er. That roller in a *carding,*

paper, calendering, or other machine, which conducts the object finally from the operative portions of the apparatus.

De-liv'er-y-valve. That valve through which the discharge of a pumped fluid occurs, as the upper valve of the air-pump in the condensing steam-engine, through which water is lifted into the hot-well.

Delph. (*Hydraulic Engineering.*) The drain on the land side of a sea embankment. It should be at sufficient distance not to encourage the percolation of water from the outside of the bank, or the slipping of the bank from outside pressure. Thirty-six feet from the foot of the bank, 12 feet width at top, 6 feet at bottom, and a depth of 4 or 5 feet, are approved proportionate dimensions.

De Luc's Col'umn. A dry galvanic pile made by alternating plates or sheets, such as silver, zinc, and paper.

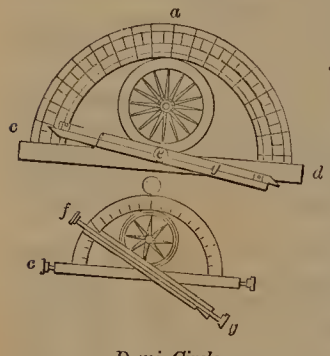
Dem'i-bas'tion. (*Fortification.*) A single face and flank, resembling the half of a bastion.

Dem'i-can'non. An old 33-pounder of 6½ inches bore and a length of 10 or 12 feet. "What's this? a sleeve? 't is like a demi-cannon."—PETRUCHIO.

Dem'i-cap'on-niere. (*Fortification.*) A construction across the ditch having but one parapet and glacis.

Dem'i-cir'cle. An instrument for measuring and indicating angles. It resembles a protractor, and has sights at each end of its diameter, also sights at each end of a rule or alidade *f g*, which has an axis at *c* over the center of the circle, so as to sweep the graduated arc *c a d*. A given object being observed from a station, through the sights *c d*, the alidade is adjusted so that the other object is observable through the sights on *f g*. The point of the rule then indicates the angle. In the middle of the instrument is a compass to show the magnetic bearings.

Fig. 1607.



Demi-Circle.

By providing the instrument with telescopes, a considerable degree of accuracy may be attained, and more distant points conveniently observed.

It is a modest substitute for the theodolite. The plane of the instrument is placed horizontally for taking distances, and vertically for hights.

Dem'i-cul'ver-in. An old 9-pounder, with 4-inch bore and a length of 9 feet.

Dem'i-gorge. (*Fortification.*) The line formed by the prolongation of the curtain to the center of a bastion.

Dem'i-lune. (*Fortification.*) An outwork of the nature of a ravelin.

Dem'i-par'al-lel. (*Fortification.*) Shorter entrenchments thrown up between the main parallels of attack, for the protection of guards of the trenches.

Dem'i-re-lief'. Or demi-rilievo. A term applied to sculpture projecting moderately from the face of a wall; half raised, as if cut in two, and half only fixed to the plane. *Mezzo-rilievo.* A degree between *alto* and *basso rilievo.*

Dem'i-ri'li-e'vo. See DEMI-RELIEF.

Dem'i-re-vet'ment. (*Fortification.*) A retaining wall for a scarp, covering it as high as protected by the crest of the glacis.

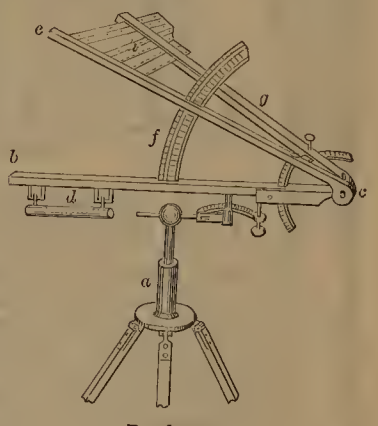
Dem'i-tint. A half-tint or medium shade of color. In studying architectural effects it is observable that the demi-tint is the shade seen when the sun's rays strike the side of a house at a certain angle, say 45°, with the ground plane.

De-my'. A size of drawing and flat writing paper, varying with different makers unfortunately, but quoted by Ringwalt as 16 × 20 or 16 × 21 inches. *Square demy* is 17 × 17 inches.

Dem'y-os'tage. A woolen stuff used in Scotland.

Den-drom'e-ter. An instrument for measuring the hight and diameter of trees, to estimate the cubic feet of timber therein. It has means for taking vertical and horizontal angles, and is mounted on a tripod stand. An upright stem rises from the top-plate, at the end of which is a ball, with a hole perforated through it to receive the horizontal stem of the instrument; *b c* may be called the base limb of the instrument, which is brought to an exact horizontal position by means of the level *d*. The limb *e* rises on a joint at *c*, and slides upon a vertical, graduated arc *f*. At the joint *c* is an eye-piece through which the surveyor looks along the side of the bar *b*, to a small point or rising edge at the end of the bar; the part of the tree cut by this line of observation will, if the tree is properly adjusted, be perfectly horizontal with the eye-piece. Another eye-piece is also placed on the upper side of the rising limb, for the purpose of looking along this limb to a point or rising edge *c* in its extremity. The surveyor elevates this limb until that part of the tree to which the measurement is designed to extend is exactly cut by the line of observation, and the angle subtended between that and the horizontal is shown upon the vertical arc *f*. The graduations of the arc *f* are not angles of altitude, but marks or graduations answering to feet and inches of a tangent line, extending from the horizontal point upward, taken at a given distance from the tree; consequently there are two or more rows of divisions, answering to the several distances at which the instrument may be planted. These may be 25 feet and 50 feet, and the graduations made accordingly; the longer distance for larger trees, and the smaller for those of lower stature.

Fig. 1608.



Dendrometer.

The horizontal angles which are to determine the diameter of the trunk, at the several points of observation, are ascertained by the limb *g*, which slides laterally upon an arc or graduated plate *h*, divided upon the same principles as the arc *f*. The limbs *b* or *c* being fixed, so as to coincide with one side of the trunk, the limb *g* is then moved until it coincides with the other side of the trunk, and the angle subtended between the two shows by the graduated plate *h* the diameter in feet and inches of the trunk at the point of observation.

The length of the trunk, and its diameter at the several parts, being thus ascertained by the instrument, recourse must then be had to tables, calculations, or the ordinary sliding rule, for the purpose

of obtaining from these measurements the solid contents of the timber in the tree. Adjusting screws, circular racks, and pinions afford means for adjusting the limbs of the instrument, and altering their position, as circumstances may require; and when crooked arms or bent portions of the trunk present themselves, the instrument may be turned upon its pin, in the ball at the top of the stem *a*, and used in an inclined position.

Den'im. (*Fabric.*) A colored, *twilled* cotton cloth used for overalls.

Den'mark-sat'in. A narrow worsted stuff, woven with a satin twill and used for ladies' shoes.

Den'net. A light, open, two-wheeled carriage like a gig, hung by a combination of three springs; two of which are placed across the axle, at right angles with it, the third being suspended from them behind by shackles.

Den-sim'e-ter. An instrument contrived by Colonel Mallet, of the French army, and M. Bianchi, for ascertaining the specific gravity of gunpowder.

It consists of a glass globe having a tube which communicates with a quantity of mercury in an open vessel. The globe is joined at top to a graduated glass tube, which may, by means of a flexible tube, be connected with an air-pump. A diaphragm of chamois skin fits over the lower, and one of wire-cloth over the upper orifice of the globe, and the tubes above and below these orifices are provided with stop-cocks.

For ascertaining the density of the gunpowder, the air is exhausted from the globe by means of the air-pump, until the mercury rises to a certain mark on the graduated tube, when the globe is detached from its support and weighed; it is then emptied and cleaned, and a given weight of gunpowder introduced, when it is again attached to the tubes and the air exhausted as before, filling with mercury all the space in the globe not occupied by the powder, up to the mark before indicated; the stop-cocks are now closed, and the globe once more detached and weighed.

The absolute specific gravity of the powder is obtained by multiplying the weight of the powder contained in the globe by the known specific gravity of mercury, and dividing the product by the product resulting from multiplying the difference between the weight of the globe when filled with mercury alone, and its weight when filled with mercury and powder, into the weight of the powder employed in the experiment.

Dent. 1. (*Weaving.*) One of the *splits* of the *reed*, which is fixed in the swinging lathe, and whose office it is to beat the *weft*-thread up to the *web*.

2. A tooth of a gear-wheel.

3. (*Carding.*) The wire staple that forms the tooth of a card. See CARD.

4. A salient knob or tooth in the works of a lock.

Den'tal Ap'pa-ra'tus and Ap-pli'an-ces. See under the following heads: —

Alveolar forceps.
Amalgam manipulator.
Anæsthetic refrigerator.
Annealing lamp.
Articulator.
Atomizer.
Automatic lamp.
Automatic mallet.
Blow-pipe.
Broach.
Bur.
Bur-drill.
Bur-gage.
Burnisher.
Cow-horn forceps.
Creosote-apparatus.
Dental chair.
Dental chisel.
Dental drill.
Dental files.
Dental hammer.
Dental plugger.
Dental pump.
Dentiscalp.
Dentist's flask.
Denture.
Excavator.
File-carrier.
Filling.
Forceps.
Fulcrum-forceps.
Hoe.
Impression-cup.
Inhaler.
Mallet.
Mouth-glass.
Nerve-instruments.
Nerve-needle.
Nippers.
Nitrous-oxide apparatus.
Pivot-tooth.
Plugger.
Plugging-forceps.
Porte-polisher.
Rubber-gage.
Saliva-pump.
Scaler.
Screw-forceps.
Soldering-lamp.
Spicula-forceps.
Spring for artificial teeth.
Stopping.
Stump-extractor.
Suction-plate.
Tape-carrier.
Thimble.
Tongue-compressor.
Tool-holder.
Tooth. Artificial
Tooth-plugger.
Tooth-saw.
Trephine.
Turnkey.
Vulcanizer.
Vulcanizing-flask.
Wedge-cutter.

Herodotus says that, in the practice of medicine and surgery, the teeth are committed to one set of physicians.

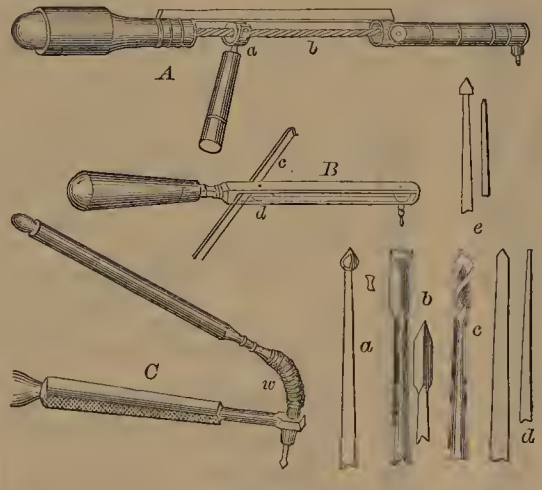
Den'tal Ar-tic'u-la'tor. An instrument for matching the dentures of upper and lower jaw. See ARTICULATOR.

Den'tal Chis'el. For excavating cavities in the teeth or cutting the natural teeth preparatory to filling. They have straight or oblique edges, and are used by a pushing action. Tools of other shapes used by a lateral, rotatory, or drawing action, are EXCAVATORS, DRILLS, BURS, etc. (which see).

Den'tal-cut Dove'tail. A dovetail having a number of dents on each part fitting within the interdental space of the fellow-portions. Drawers and well-constructed boxes are thus secured at their corners.

Den'tal Drill. An instrument for cutting out carious portions of teeth; for opening out a nerve-

Fig. 1609.



Dental Drills.

cavity, for plugging, or for the insertion of a pivot. The drills are sized and shaped for their work.

a, Scranton-drill.
b, square-drill.
c, auger-drill.
d, flat-drill.
e, Forbes-drill.

A is a drill-stock having a nut *a*, traversing on a spiral stem *b*. *B* has a bow *c*, whose string operates the whorl *d* and the tool-socket. *C* has a separate handle and flexible coupling *w*.

Den'tal File. One made for use in operative or mechanical dentistry. Among these may be enumerated the following. Their names are indicative of their purposes.

Biscuspid file.	Molar file.
Feather-edged file.	Plug-finishing file.
Finishing file.	Separating file.
Lateral file.	Stump file.
Knife-edge file.	Vulcanite file.

Den'tal For'ceps. The dentist uses a variety of operating-forceps. Some are distinguished *by their objective names*, as —

Upper forceps.	Molar forceps.
Under forceps.	*Dentes sapientiæ* forceps.
Front forceps.	Root forceps.
Back-forceps.	Alveolar forceps.
Incisor forceps.	Spicula forceps.
Bicuspid forceps.	

By shape or peculiar conformation : —

Straight forceps.	Narrow-beak forceps.
Curved forceps.	Cow-horn forceps.
Bayonet-shape forceps.	Fulcrum forceps.
Hawk's-bill forceps.	Screw forceps.

By the kind of duty : —

Excising forceps.	Nipping forceps.
Separating forceps.	Plugging forceps.

Den'tal Ham'mer. An instrument for plugging teeth; operated by the alternate pressure and relaxation of pressure of the stock upon the point. The plugging-tool presses against the filling in the tooth; pressure on the case makes the tool-stock recede, imparting its movement to the lifting-bar and hammer, until the bar passes the incline of the wedge, releases its hold on the catch, and releases the hammer, which descends under the influence of the spring. The force is adjusted by devices operated by an exterior band.

Fig 1610.

Dental Hammer.

Den'tal Plug'ger. An instrument for compacting the metallic filling of teeth.

Fig. 1611.

Dental Plugger.

The point of the plugger continues to press upon the metal in the cavity of the tooth, being actuated by the tension of the spring, while the tube is reciprocated and acts by concussion on the end of the stem.

Den'tal Pump. An apparatus for withdrawing the saliva from the mouth during dental operations. See SALIVA-PUMP.

Den'ted Chis'el. (*Sculpture.*) A chisel with a dentated edge, used in carving stone.

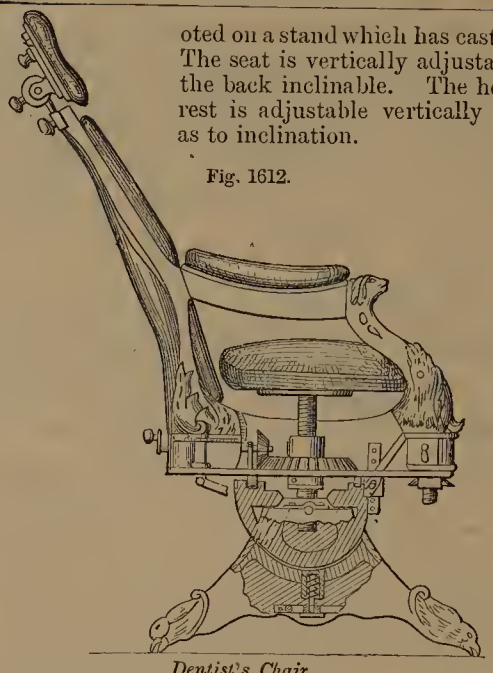
Den-telle'. (*Bookbinding.*) An ornamental tooling resembling notching or lace.

Den'til. (*Architecture.*) A small projecting block in a cornice. Frequently introduced in a row beneath the *corona*.

Den'ti-scalp. An instrument for scaling teeth.

Den'tist's Chair. A chair provided with numerous adjustments to suit the exigencies of surgical dentistry. The chair itself is pivoted on a stand which has casters. The seat is vertically adjustable, the back inclinable. The head-rest is adjustable vertically and as to inclination.

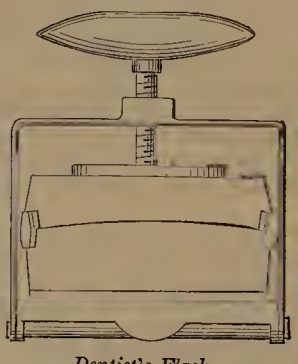
Fig. 1612.



Dentist's Chair.

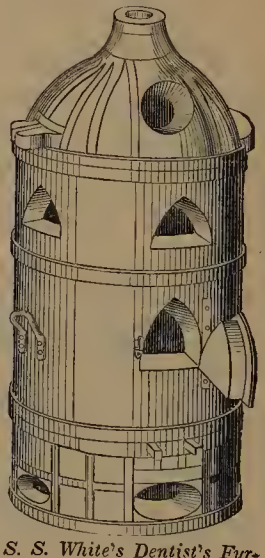
Den'tist's Flask. A case in which a molded vulcanite base for dentures is subjected to the heat of the muffle. A clamp holds the parts of the flask in perfect apposition.

Fig. 1613.



Dentist's Flask.

Fig. 1614.



S. S. White's Dentist's Furnace.

Den'tist's Fur'nace. A furnace for *baking* and *burning* porcelain teeth. It is made of fire-clay, and hooped with sheet-iron. The figure shows the furnace arranged for two muffles. The latter are chambers, like those in an assay-furnace, except that they are destitute of the slots which admit the flame to the contents of the muffle. The lower opening in the furnace is for draft, and leads to the ash-pit.

The opening above, with a door, is that of the principal muffle in which the porcelain teeth are *burned*. In these articles, as in the usual porcelain work, there are several operations. The teeth are molded and then *baked*, which forms them into biscuit. They are then painted with enamel compound, and a second operation, with much increased heat, vitrifies the enamel and completes the operation, which is termed *burning*.

The upper muffle is for *baking* and also for *annealing*, the teeth *burned* in the lower muffle being subjected in the upper one to a lower heat, which is allowed gradually to abate, so that the teeth shall not crack.

The opening in the dome is for fuel, and that in the top for a chimney.

These furnaces are oval in form, with hinged doors, the center sections cased with sheet-iron. The muffles are 12 inches long by 3¾ inches wide, inside measurement. The outside measurement of the furnace is 43 inches high, 21 inches wide, and 16 inches deep.

Den'ture. An artificial tooth, block, or set of teeth. The former are *partial* dentures, the latter is a *full* denture.

They may be classified as follows : —

A *pivot-tooth* is an artificial crown set upon a natural root.

Dentures made from *dentine* or river-horse teeth, plate and teeth carved from a solid block.

Plates carved from dentine to fit the gums, or the gums and the roof of the mouth, upon which are pivoted natural human teeth.

Plates made of gold or silver fitted to the mouth and mounted with porcelain teeth.

Continuous-gum dentures. Plates made of platinum and mounted with porcelain teeth, around the necks of which, and upon the lingual surface of the plate, a silicious compound or enamel is fused.

Mineral-plate dentures. Made entirely of porcelain ; plate and teeth molded and carved from porcelain mixture, enameled and burned.

Plates made of *vulcanized rubber* with *porcelain teeth*, secured by being embedded previous to the process of vulcanizing, assisted by pins and staples of platinum.

Plates made by casting a base metal alloy, with porcelain teeth secured by being partially embedded in the casting.

Under the date of March 11, 1664, Pepys writes : "My wife come home, and she had got her tooth new done by La Roche, and are indeed now pretty handsome, and I was much pleased with it."

Fig. 1615.

Denture.

The Japanese *Hadsikfsan*, or "tooth carpenter," is an itinerant artist who makes his teeth of ivory, shark's teeth, or stone, let into the wooden base, and retained in position by being strung on a thread, which is secured at each end by a peg driven into the hole where it makes its exit from the base. Iron or copper tacks are driven into the ridge to serve for masticating purposes, the unequal wear of the wood and metal keeping up the desired roughness of surface. To construct a full upper and lower denture requires about two days' constant work, which becomes five, owing to the frequent chats, naps, and smokes. An impression of the mouth is taken in wax, another impression had from this ; the latter is smeared with red paint, and a wooden block fitted to it by gradual trials and approximations.

Among the technical terms appertaining to dentures are : —

Pivot-tooth, an artificial crown secured to a natural root by the insertion of a pivot, or pin.

Plate-tooth, one fastened to a plate.

Plain-tooth, one without any gum.

Gum-tooth, one made with a portion of gum attached.

Block, two or more teeth made unitedly.

Set, a full furnishing for one jaw.

Base, that which artificial teeth are mounted on or attached to.

Mounting, attaching teeth to a *base*.

De-o'dor-iz'er. A drug or pastille applied to, or burned in the presence of, putrescent, purulent, infectious, or fetid matter.

Deodorizers are a sanitary provision for the defecation of matter having noxious effluvia ; acting to render the matter inert, to absorb it mechanically, or only to disguise it, supplanting the fetor by superior energy, as in the use of aromatic pastilles.

Sanatory experts (L., *sanator*, a healer of diseases, a physician) have devised these *sanitary* expedients (L., *sanitas*, health) to isolate infection and thus prevent the spread of disease. See also DISINFECTOR.

De'phleg-ma'tor. A form of condensing apparatus for stills, consisting of broad sheets of tinned copper soldered together, so as to leave narrow spaces between them.

Dep-i-la'tion. A very good term to describe the process which is usually called *unhairing*. It consists in the loosening and removal of hair from hides and skins, and is usually accomplished by lime. It is hence called *limeing*.

Lime being injurious to leather, other processes have been suggested and to some extent practiced. See UNHAIRING.

De-press'or. (*Surgery.*) An instrument like a curved spatula, used for reducing or pushing into place an obtruding part. Such are used in operations on the skull involving the use of the trephine, and in couching a cataract. Also used in removing beyond the range of the knife or the ligature needle a portion intruding within the area of the operation.

Dep're-ter. Plastering done to represent tooled ashlar-work. It is first pricked up and floated as for *set* or *stucco*, and then small stones are forced on dry from a board.

Depth'en-ing-tool. 1. A countersinker for deepening a hole.

2. A watchmaker's tool for gaging the distances of pivot-holes in movement-plates.

Depth-gage. A graduated measuring-tool, or one capable of being set to a measure to determine the depth of a hole.

Dep'u-ra'tor. An apparatus to assist the expulsion of morbid matter by means of the excretory ducts of the skin. It consists of an apparatus, topical or general, by which the natural pressure of the air is withdrawn from the surface of the body.

The *depurator* is described in Nathan Smith's English patent, 1802. The chamber is filled with steam and the air exhausted to the extent required by the patient, "giving aid to the elastic force of the internal air contained within the human body to throw out the offensive matter."

De-rail'ment. (*Railway Engineering.*) The condition of a locomotive or car in respect of being off the rails.

Der'by. (*Masonry.*) A two-handed float.

Der'mal In'stru-ments. (*Surgery.*) Instruments acting upon the skin, such as the acupuncturator, hypodermic syringe, scarificator, artificial leech, cupping-glass, vacuum apparatus, depurator, etc.

Der'mo-path'ic In'stru-ment. An acicular instrument used to introduce a vesicatory beneath the skin. See ACUPUNCTURATOR ; HYPODERMIC SYRINGE, etc.

Der'rick. A form of hoisting-machine. The peculiar feature of a derrick, which distinguishes it from some other forms of hoisting-machines, is that it has a boom stayed from a central post, which may be anchored, but is usually stayed by guys.

A *derrick* has one leg, a *shears* two, and a *gin* three. A *crane* has a post and *jib*. A *whin* or *whim* has a vertical axis on which a rope winds. The *cap-*

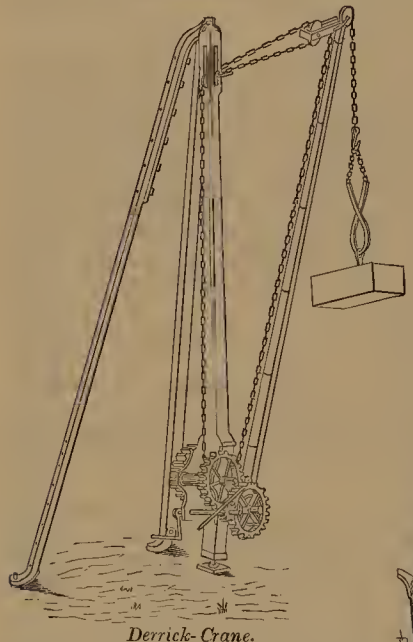
stan has a vertical drum for the rope, and is rotated by *bars*. The *windlass* has a horizontal barrel, and is rotated by *handspikes*. The *winch* has a horizontal barrel, and is frequently the means of winding up the tackle-rope of the derrick; it is rotated by *cranks*. The *crab* is a portable winch and has cranks.

The derrick is more commonly used in the United States than in Europe, and has attained what appears to be maximum effectiveness with a given weight. Two spars, three guys, and two sets of tackle, — one for the jib and one for the load, —complete the apparatus, except the winch, crab, or capstan, for hoisting.

The invention is nautical, the original being the sailor's contrivance, made of a spare topmast or a boom, and the appropriate tackle. Such are used in masting, putting in boilers and engines, and hoisting heavy merchandise on board or ashore.

The *derrick-crane* is a combination of the two

Fig. 1616.



Derrick-Crane.

devices, as its name imports, having facility for hoisting and also for swinging the load horizontally.

The machine illustrated was made by Wightman of Edinburgh, Scotland, and consists of a vertical post supported by two timber back-stays whose feet are anchored to the earth. The *jib* or movable spar of the derrick is hinged to and near the foot of the post, its top being held by a chain which passes over pulleys to a winch on the post, so that the inclination of the jib may be adjusted as required. The fall of the hoisting-tackle is passed over a sheave on the summit of the jib, and thence down the jib to the hoisting-winch. This derrick-crane commands a radius of from 10 to 60 feet without being moved from its position.

Bishop's floating-derrick was used in 1850 in raising sunken vessels, and consists of a flat-bottomed vessel, 270 feet long and 90 feet beam. It was built by the Thames Iron Shipbuilding Company at Blackwall, and has a number of water-tight compartments, which can be filled, so as to counterbalance any weight on the opposite side. From the deck of this vessel rises an iron tripod, 80 feet high, on the top of which revolves a gigantic boom, 120 feet long, and above the boom the king-post, a continuation of the tripod, rises to the hight of 50 feet.

One arm of the boom is furnished with ten fourfold blocks. The chains attached to these blocks are passed across the king-post, brought over the other arm of the boom, and thence descend to the other side of the vessel, where they are connected to crabs worked by two powerful steam-engines, by means of which the weights are raised.

This floating-derrick is capable of self-propulsion by means of paddle-wheels, and thus removes its suspended load to a position of safety for repair or other purpose.

The present extensive use of horse hay-forks for hoisting hay in stacking or mowing has given rise to a number of inventions for obtaining an elevated point of support for the upper pulley.

Fig. 1617.

Bishop's Floating-Derrick

Some of these are on portable frames, or wagon-bodies. Others are true *derricks*, with a jib or spar stayed by guys. Some more nearly resemble the *crane*, others the *gin*. Many minor peculiarities distinguish them, but in their general features their construction is fairly referable to those described under the various heads.

The floating-derrick of the New York Department of Docks was built under the supervision of Mr. Newton, assistant-engineer of the department. It was constructed expressly for the purpose of trans-

FLOATING DERRICK.

PLATE XIII.

NEW YORK DEPARTMENT OF PUBLIC WORKS.

See page 683.

porting from the work-yards the blocks of granite and artificial stone that are to form the river-wall. Its lifting and carrying power is 100 tons, and the float which carries the derrick is of rectangular form, 66 by 71 feet, and 13 feet in depth. It is stiffened by sixteen trusses, extending from the deck to the bottom, and running across from side to side.

The tower, which is placed upon the float, and supports the king-post and booms, is made of twelve balks of pine, 63 feet 3 inches in length, and 14 inches square. These balks or legs are stiffened from one end to the other by struts and braces; their lower ends are bolted into a heavy cast-iron circle, which, in its turn, is held down by numerous bolts which pass through the bottom of the floor. At their upper extremity these legs are brought close together, and are inserted in a cast-iron cap, to which they are bolted. The tower forms a frustum of a dodecagonal pyramid 40 feet in diameter at the base, 52 feet in hight, and 12 in diameter at the top.

The front or hoisting boom of the derrick consists of two wrought-iron box-girders 22 inches deep by $9\frac{3}{4}$ inches wide. These girders are made of planed plates, are spaced 24 inches asunder, and are held parallel by braces of wrought-iron; on the upper and inner edges of these girders a track or slide of polished brass is fastened by counter-screws. These tracks have a projector which extends a short distance downward; the carriage which carries the main hoisting-blocks slides on them. The carriage is composed of two plates of iron $\frac{3}{4}$ of an inch thick, and spaced 10 inches asunder; its length is 8 feet, its depth 3 feet. The iron boom is supported by eighteen diagonal rods $2\frac{1}{8}$ inches in diameter. These converge near the top of the king-post, and are secured to it by three heavy forgings, which straddle the iron cap on the top of the post.

The king-post is of wrought-iron, 40 inches outside diameter. It is hollow, and its shell is $\frac{3}{4}$ of an inch thick. It revolves in a circular casting, swinging the boom completely around.

All the machinery is placed on the float under the tower, and the levers which operate it and give the various movements are brought together on a platform 35 feet above the deck of the float, so that the person operating them acts in full view of the load that is being handled. (See plate opposite.)

De-scend'ing-let'ter. (*Printing.*) One of those which descend below the line, as *f*, *g*, *j*, *p*, *q*, *y*.

Des'ic-ca'tion. The evaporation or drying off of the aqueous portion of bodies; practiced with fruit, meat, milk, vegetable extracts, and many other matters. It is usually done by a current of heated, dry air, and as such may be considered as distinguished from evaporators, so called, to which furnace heat or steam heat is applied.

De-sil'ver-ing. The process of removing lead from an alloy with silver by means of removing crystals of the former from the cooling alloy. The Pattinson process.

Desk. A sloping table, frame, or case for a writer or reader. In the illustration are several forms of school-desks.

A shows a desk with a seat for the scholars in the row in front of it. A single seat is required for the rear row.

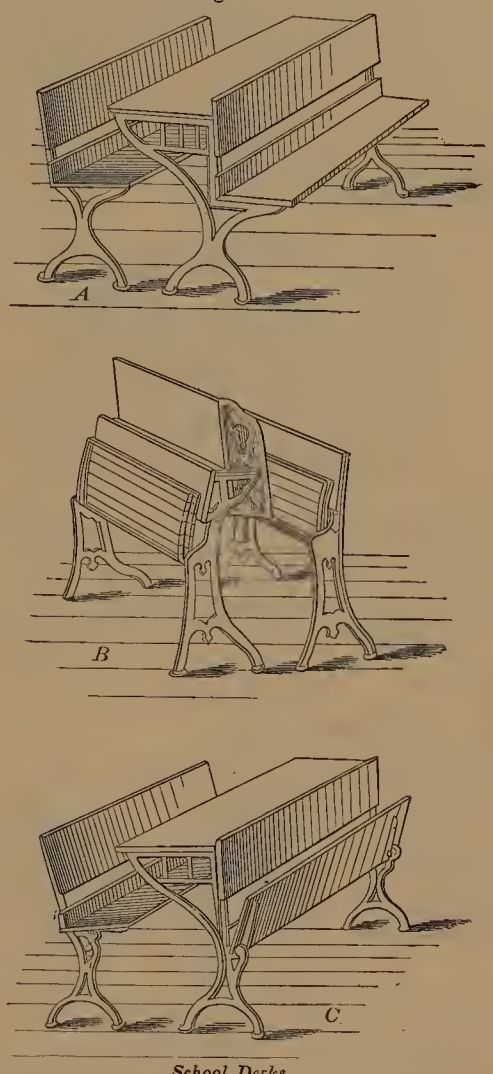
B shows a desk and seat capable of folding for transportation and for sweeping.

C, the seat only folds.

Desk-knife. An *eraser*.

Des-tem'per. A mode of painting with opaque colors, principally used for walls, ceilings, domes, scenes, etc., in which the colors are mixed with chalk or clay and diluted with size. *Tempera*

Fig. 1618.



School-Desks.

painting was practiced in ancient Egypt. The wall was covered with a coating of lime or gypsum. The outline was sketched in with red chalk and then filled out with black. The painter levigated his colors and mixed them with water, placed them on a palette hung to his wrist, and applied them to the surface on which he was at work.

It was also practiced in Greece and Rome. The cartoons of Raphael are in destemper. It is common for auditoriums. Kalsomine (or calcimine) is a form of it. Sometimes written *distemper* or *tempera*.

De-sul'phur-iz'ing Fur'nace. (*Metallurgy.*) A roasting-furnace for driving off the sulphur from pyritic ores. There are many forms adapted to the requirements of different ores, facilities of building, kind of fuel, and the more or less perfect result demanded by the value of the metal and other commercial and economical incidents.

Ores are desulphurized by roasting in heaps.

In reverberatory furnaces of the usual kind. See COPPER-FURNACE.

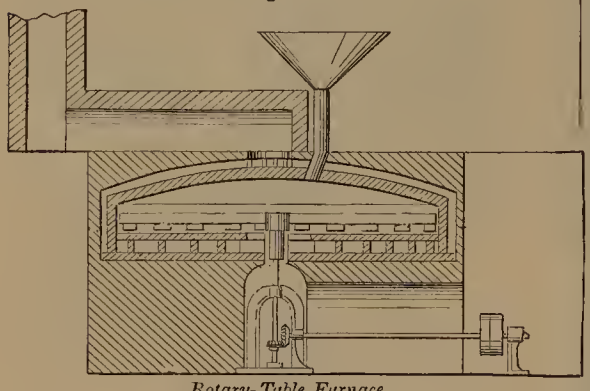
In rotary inclined cylinders exposed to the heat of a fire beneath.

In a flue or stack where it falls through a column of flame. See DECARBONIZING-FURNACE.

On a rotary-table furnace (as in Fig. 1619), where the desulphurizing-chamber is surrounded with flues through which the caloric currents from the furnace are compelled to pass on their way to the chimney.

Within the chamber is a stirrer provided with conveyors and operated by gear-wheels. The pulverized

Fig. 1619.

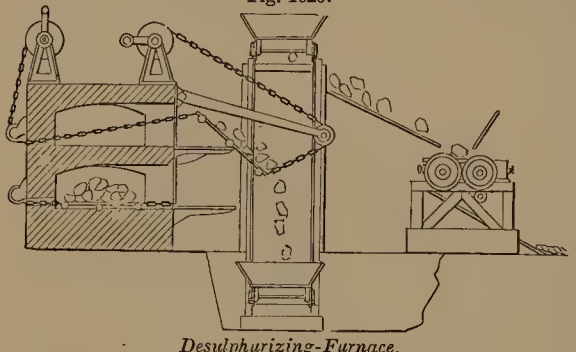


Rotary-Table Furnace.

ore is placed in the center of the oven, and carried by the conveyor to the discharge-hole near the outside.

Another form is that in which the ore is placed on movable plates, and, when heated to redness, is drawn

Fig. 1620.



Desulphurizing-Furnace.

out of the furnace by the chains, and dumped into water. When removed from water, it is crushed before passing to the cupola.

In Hagan's process, superheated steam is introduced into the furnace and decomposed, the hydrogen flame attacking the sulphur, arsenic, and antimony.

De-tached' Es-cape'ment. The detached escapement was invented by Mudge in the seventeenth century.

Earnshaw's detached escapement has two vibrations of the balance for each impulse, resembling the duplex in this respect. *A* is the main pallet projecting from the balance-arbor, concentric with which is another small pallet, called the *lifting*-pallet, which, when the balance is vibrating from *A* towards *B*, lifts a very slender spring *B*, and with it the detent-spring *C*, so as to set at liberty or unlock the tooth *D*, the point of which rests on a ruby pin projecting from the detent-spring *C*, and forming the detent.

Fig. 1621.

Detached Escapement.

The point *E* of the principal pallet having passed the tooth *F*, the wheel moves forward by the action of the mainspring, while the next tooth *G* falls upon the ruby pin and is locked. The screw *H* serves to adjust the position of the detent and the strength of the locking. In the return of the balance, the pallet *A* passes easily by the detent-spring by forcing back the slender spring *B*.

This is a chronometer escapement.

The term *detached* is also applied to the ordinary form of lever-escapement with two pallets, which engage the teeth of the scape-wheel, and a fork which engages a pin on the balance-arbor. The term *detached*, in this case, is to distinguish it from the *anchor*-escapement, wherein a segment-rack engages a pinion on the balance-arbor. See LEVER-ESCAPEMENT.

De-tached' Work. (*Fortification.*) A work included in the defence, but placed outside the body of the place.

De-tach'ing Horses from Car'riages. A means for suddenly releasing an unmanageable team from the vehicle.

The Marquis of Worcester, in his "Century of Inventions," 1655, describes an apparatus of this kind, under command of the passengers, in which, "by means of a T-ended lever, two or four bolts could be simultaneously drawn inwards, and the horses thereby released with the greatest possible ease and certainty."

Hohlfield of Saxony, 1711–71, contrived a carriage in which the person could by a single push loosen the pole and set the horses at liberty.

Williams's English patent, 1802, operates by a cord releasing a bolt, which allows the studs to which the traces are attached to rotate and the traces to slip off.

Since these, numerous devices have been suggested, but have not come extensively into use.

De-tect'or. 1. An arrangement in a lock, introduced by Ruxton, by which an over-lifted tumbler is caught by detent, so as to indicate that the lock has been tampered with.

In Mitchell and Lawton's lock, English, 1815, the motion of the key throws out a number of wards, which engage the key and keep it from being withdrawn until the bolt is moved, when the pieces resume their normal position and release the key. Should the key fail to act upon the bolt, it cannot be withdrawn, but the lock must be destroyed to release it.

Chubb had a *detector* in his lock of 1818.

2. A means of indicating that the water in a boiler has sunk below the point of safety. See LOW-WATER DETECTOR.

De-tent'. A pin, stud, or lever forming a stop in a watch, clock, tumbler-lock, or other machine. It is variously called in specific cases; as, *click*, *pawl*, *dog*, *fence*, etc. It is usually capable of motion, either at certain intervals, as in some escapements, or by operation of a key, as in locks.

A detent-catch falls into the striking-wheel of a clock, and stops it from striking more than the right number of times. The watch-escapement has also a *detent*.

The ratchet-wheel has a *click*, to prevent back motion.

The windlass has a *pawl*, to fall into the notches of the rim.

Det'on-at'ing-ham'mer. The hammer of a percussion gun-lock.

Det'on-at'ing-pow'der. One which explodes by a blow. The compound used in the priming of percussion-caps and fuses is the fulminate of mercury or of silver, collected as a precipitate when the metal, dissolved in nitric acid, is poured into warm alcohol. The precipitate is collected, washed, and dried.

Det'on-at'ing-pri'mer. (*Blasting.*) A primer exploded by a fuse, and used in blasting operations to violently explode gun-cotton, instead of the former plan by which the charge of gun-cotton was simply ignited.

Det'o-nat'ing-tube. A graduated tube used for the detonation of gases, being pierced by two opposed wires by which an electric spark is introduced. The gas is confined over water or mercury. See EUDIOMETER.

Det'o-na'tion. Instantaneous combustion with loud explosion.

De-vel'op-ing. (*Photography.*) The treatment of an exposed sensitive photographic surface with a solution of a protosalt of iron (generally sulphate of iron), pyrogallic acid, or gallic acid, in conjunction with a small amount of nitrate of silver, either present in the film or added, so as to call into visible existence the latent picture produced in the camera or under a negative; an operation always performed in an actinically dark room, that is, one in which the rays at the violet end of the spectrum are excluded.

Fig. 1622.

Developing Stick.

The developing-stick has a suction-pad of india-rubber, by which it is made to cling to the glass, allowing great freedom of motion without danger of becoming detached.

De-vel'op-ment. (*Shipbuilding.*) The process of drawing the figures which given lines on a curved surface would assume, if that surface were a flexible sheet and were spread out flat upon a plane without alteration of area and without distortion.

Surfaces not truly developable are drafted on a plane surface by the process termed EXPANSION (which see).

De-ver'soir. (*Hydraulic Engineering.*) Of a dike, the fall.

Dev'il. 1. A machine for opening out the tussocks of cotton, and cleaning therefrom the dirt and offal. It has various other names, such as *willower*, *willy*, *beating-machine*, etc. See COTTON-CLEANING MACHINE.

2. A rag-engine or spiked mill for tearing woolen rags into shoddy, or linen and cotton rags to make paper pulp.

3. A machine for making wood screws.

Dev'il-car'riage. A carriage used for moving heavy ordnance. A *sling-cart.*

Dev'il's Claw. A grapnel.

Dew-point. The point of temperature at which the moisture of the air commences to condense. See HYGROMETER.

Dew-ret'ting. The process of softening and removing the mucilage from the fibrous and cellular portions of the stalks of flax and hemp, by exposure to *dew*, showers, sun, and air upon a sward. See RETTING.

Dex'trine. A gummy material made from starch and largely used in the manufacture of calico. Its name is derived from its right-handed rotation of a ray of plane polarized light.

Torrefied starch; roasted at a temperature of 300° F. *British gum.*

Potato starch moistened with water, acidulated by nitric acid, dried spontaneously and then in a stove at 212° F.

Dho'ney. A native coasting-vessel of India with two masts and not exceeding 150 tons.

Dhow. An Arab vessel with a single mast, a yard the length of the vessel, and a lateen sail. They are from 150 to 200 tons burden.

Di'a-caus'tic. A double-convex lens used in cauterizing parts of the body.

Di-ær'e-sis. (*Printing.*) A mark (··) placed over the second of two adjacent vowels to indicate that they should both be pronounced; as, *aërated.*

Di'a-gom'e-ter. An electroscope invented by Rousseau, in which the dry pile is employed to measure the amount of electricity transmitted by different bodies; to determine their conductivity.

Di-ag'o-nal. (*Shipbuilding.*) 1. A timber brace, knee, plank, truss, etc., crossing a vessel's timbers obliquely.

2. A line cutting the body-plan diagonally from the timbers to the middle line.

3. An oblique brace or stay connecting the horizontal and vertical members of a truss or frame.

Di-ag'o-nal-built. (*Shipbuilding.*) A manner of boat-building in which the outer skin consists of two layers of planking making angles of about 45° with the keel in opposite directions.

They are built, like clinker-built boats, upon temporary transverse molds. After setting up and fixing the molds upon the keel, the gunwale, a shelf-piece, and a series of rib-bands are temporarily fixed in the molds. Two layers of planking are then put on, bent to fit the molds and rib-bands, and fastened to each other and to the keel, stem, stern-post, shelf, and gunwale with nails, driven from the outside, and clenched inside upon small rings, called *roves.* The gunwale is then shored, to keep it in shape. The molds and rib-bands are taken out, and floors, hook, thwarts, etc., are put in as in a *clinker-built* boat.

Di-ag'o-nal Eye-piece. Used for solar observations. A very small percentage of the sun's light and heat is reflected from the first surface of a prism, the rest being transmitted.

Di-ag'o-nal Fram'ing and Stays. (*Steam-engine.*) The oblique frame and braces which connect the plumber-block of the paddle-shaft with the framing of the side-lever steam-engine.

Di-ag'o-nal Lines. (*Shipbuilding.*) Lines showing the boundaries of various parts, formed by sections which are oblique to the vertical longitudinal plane, and which intersect that plane in straight lines parallel to the keel. Usually drawn in *red* in the draft.

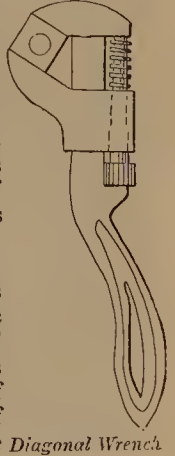
Di-ag'o-nal Rib. A projecting band of stone or timber passing diagonally from one angle of a vaulted ceiling across the center to the opposite angle.

Di-ag'o-nal Scale. A mathematical scale in which the smaller divisions are made by lines that run obliquely across the larger divisions.

Di-ag'o-nal Tie. An angle-brace.

Di-ag'o-nal Wrench. An S-shaped wrench adapted to be used in corners where the ordinary wrench will not turn.

Fig. 1623.



Diagonal Wrench.

Di'al. 1. An instrument for showing the time of day by the sun's shadow.

Since man first looked up and regarded the sun, its apparent diurnal course has been the measure of time as to parts of days, as the recurrences of his visits have formed the units of the still greater period which marks his complete circuit in the zodiac.

"Between day-break and sun-up" may be a local expression, but it has its analogues in all idioms, and like its congeners, "an hour by the sun," and "the sun two hours high," marks the constant reference by those of out-door occupation to the master of day as the measurer of time. In the

latitude of Ohio, a farmer judges of noon in harvest-time by reaching one foot forward to try whether he can step on to the shadow of his head. The tired farm-servant of Mesopotamia "earnestly desired the [eastward] shadow," as he watched the sun gradually decline in the western sky.

It is useless, then, to expect to give a date for the invention of the sun-dial. It was not an *invention*, but an *observation*.

It is evident that the dial having a gnomon which makes with the horizontal plane an angle equal to the latitude of the place is the invention of the Asiatics. It is bootless to inquire whether it originated on the southern slope of the great backbone of the continent, or in far Cathay, by the Yellow Sea. Herodotus, whose fame grows clearer and brighter as years wax and wane, states that the Greeks received the sun-dial from the Chaldeans (see that of Berosus, *infra*). We may fairly judge the character of the ancient dials from those yet remaining in India, which are destitute of modern innovations, such as glass lenses and finely graduated metallic scales.

Dr. Hooker, in his "Notes in Bengal, Nepaul, etc," gives sketches of the sun-dials in the Observatory of Benares. This observatory was built by Jey Sing, Rajah of Jayanagar, upwards of 200 years ago. His skill in mathematical science was so great that the Emperor Mohammed Shah employed him

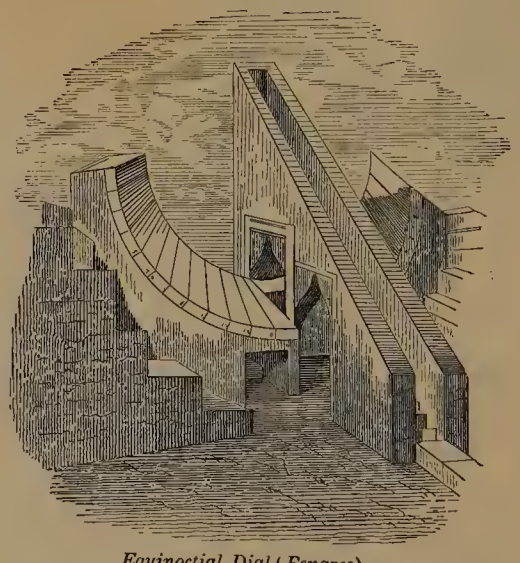
Fig 1624.

Equatorial Sun-Dial (Benares).

to reform the calendar. He also built the observatories of Delhi, Matra on the Jumna, and Oujein. The *Narec-inla*, or equatorial sun-dial, has a face 26 inches in diameter; the *Semrat-yunta*, or equinoctial sun-dial, has a gnomon 30 feet long, and each quadrant is 9 feet long. These instruments, which are shown in a group in Fig. 309, are particularly interesting, as they carry the eye back to the times of the Chaldean astronomers. There is no reasonable doubt but that these instruments, absolutely devoid of lenses and tubes, are similar to those used by the observers of Mesopotamia and the valley of the Nile, 4,000 years ago. The dial of the Hindoos is described in the Sûrya Siddhânta, or Sanskrit text-book of astronomy, translated for the American Oriental Society, and published in their journal, Vol. VI.

About 771 years before the Christian Era, the Assyrian king Phul invaded Samaria. Thirty-one years afterward, Pekah of Samaria besieged the young King Ahaz in Jerusalem, and the latter sent to Tiglath-Pileser, the Assyrian, then in Damascus, for help against his enemy. This was given. When Ahaz went to Damascus to greet his benefactor, he saw a beautiful altar, and sent working drawings of it to Urijah, the priest in Jerusalem. An altar was completed against his return. In the same spirit of enterprise and taste, and probably from the same trip of observation, he set up the dial which is mentioned in the account of the miraculous cure of his son Hezekiah, thirteen years after Ahaz was gathered to his fathers. This is perhaps the first dial on record, and is 140 years before Thales, and nearly

Fig. 1625.



Equinoctial Dial (Benares).

400 years before Aristotle and Plato, and just a little previous to the lunar eclipses observed at Babylon, as recorded by Ptolemy.

The opinions as to the construction of the dial of Ahaz vary considerably, and the Hebrew word is said, by Colonel White of the Bengal army, to signify a *staircase*, which much strengthens the inference that it was like the equinoctial dial of the Indian nations and of Mesopotamia, from whence its pattern is assumed to have been derived. Cyril, of Alexandria, — the murderer of Hypatia, and not very good authority, — and Jerome, a much better man, agreed in supposing that it had a gnomon and a graduated circle on which the shadow of the gnomon was thrown. The diurnal division of time in the observatories of Chaldea was probably a certain fraction of a solar day; but with most nations the *natural* day was the period between sunrise and sunset, which was divided into twelve periods, which were only the equivalent of our hours at the equinoxes, when days and nights are equal; in summer they were longer and in winter shorter than at the equinoxes. The Chaldeans, Syrians, Hindoos, Persians, Egyptians, Greeks, and Romans thus divided the daylight into twelve periods or hours, while the civil day was the solar day and had twenty-four hours. The dial of Ahaz may have had a vertical gnomon on the upper one of a series of steps, the time being determined by the shadow of the point of the gnomon on the graduations of that arc-shaped step which was designed for that season of the year at which the observation was made. It might thus resemble the analemma, described by Vitruvius, which, by marking the length of the shadows of a fixed gnomon, showed the different altitudes of the sun at the different seasons of the year. Grotius supposed

the dial of Ahaz to be a concave hemisphere with a central globe whose shadow fell on the lines engraved on the concavity. This would resemble the Greek *scapha*, a semicircular concave dial, or *hemicyclium*, ascribed by Vitruvius to Berosus the Chaldean, 340 B. C. ; this was long in use in Rome, aud many have been discovered. It consisted of a semi-spherical horizontal basin with a style erected in such a manner that its extremity was exactly at the center of the sphere. The shadow of the point of the gnomon on the concave surface had the same position with regard to the lower sphere that the sun occupied in the apparent spherical dome of the heavens, eleven converging lines in the concave part dividing it into the twelve hours of the day. So much for the surmises of those whose studies were of Greece and Rome, but to whom the whole Oriental world was not, or was but as a distant and unintelligible murmur. How little even Alexander suspected — he who penetrated the farthest into the teeming and contemplative East — that the most complex and elaborate language of which the world had any knowledge — the Sanskrit — had just ceased to become a spoken tongue! How near the astute Greek came to opening the volume which Providence has given to be the delight and the wonder of the philologists of the nineteenth century! We adhere to the supposition that the dial of Ahaz was a structure like that of Benares.

It will be noticed that the chronicler does not state the result in hours, but in degrees, — a mathematical mode of statement which shows that it had reached its then form through the hands of the astronomers, with whom the division of the circle into 360° was usual at the earliest recorded period at which astronomical instruments are mentioned. The aucient horary division of the Hindoos was into sixty hours. The Chinese divide the solar day into twelve periods, each equal to two of our hours. The Japanese divide the solar day in the same manner, but for common customary purposes the period of daylight iuto six equal parts. The length of the divisional portions of daylight would therefore vary with the season, but extreme accuracy is dispensed with, and the variations are regulated four times in a year upon the average of three months. The earliest mention of hours is perhaps in Daniel iv. 19, when the prophet became "astonied for one hour." As Daniel was of the great men, we may assume that his coma lasted about sixty of our minutes, as he probably regarded the horary division of the astrologers, rather than the vulgar and fluctuating term of the populace. It is not insignificant that the word *hour* occurs but once in the common translation of the Old Testament, sixty-seven times in the New Testament.

The weekly period is mentioned in the oldest book in the world (Genesis), and dates from the planting of man upon this sphere. The nomenclature of the days, placing them under the regency of the planets, is ascribed to the Chaldeans by some of the ancients, but Dion Cassius (XXXVII. 18) says, with as great probability, that the Egyptians were the first to refer the days to the seven planets. They used the hebdomadal division for certain religious observances, but also the decades or divisions by tens of days, which is also used by the Chinese. Their twelve hours of day and twelve of night were also each dedicated to a genius called *Nau* (hour). Night was held to precede day : "The evening and the morning were the first day" (Gen. i. 5).

The Chinese, ancient Romans, modern European nations, and astronomers generally began or begiu the day with midnight; the Chaldeans, Syrians, Hindoos, and Persians with sunrise. With the former he is a great fact, with the latter a god.

"The Egyptians, they said, were the first to discover the solar year, and to portion out its course into twelve parts. They obtained this knowledge from the stars. To my mind they contrive their year much better than the Greeks, for these last intercalate every other year a whole month, but the Egyptians, dividing the year into twelve months of thirty days each, add every year a space of five days [and a quarter] besides, whereby the circuit of the seasons is made to return with uniformity." — HERODOTUS II. 4.

"These [Egyptians] of Thebes seem most accurately to have observed the eclipses of the sun and moon ; and from them do so manage their prognostications that they certainly foretell every future event." — DIODORUS SICULUS (60 B. C.).

The Egyptians had the true heliocentric theory of the solar system, which the Greeks could not receive, and which was revived twenty centuries afterwards by Copernicus. It was a great event for Europe when Psammeticus, about 650 B. C., opened the ports of Egypt to the other Mediterranean nations, and encouraged the Ionians and Carians to settle there.

The horoscopus, who occupied the second place in the procession of the Egyptian priests, carried a *horologium*, or sun-dial.

The dial is mentioned in the book of Tobit, which is supposed to have been written by a Jew of Palestine, detailing the experiences of an Israelite of the tribe of Naphthali, who lived in Nineveh in the reigns of Shalmanezer and Sennacherib.

Perhaps the true order of statement would have been better preserved if we had commenced the history of the dial with the Chinese, who are stated, no doubt truthfully, to have used the gnomon from the earliest antiquity ; but the notices attainable are so scattering and vague that it is difficult to associate them with the definite details which have been principally referred to so far. The study of astronomy in China is as ancient as the time of Abraham, and the earliest known observations are Chinese (see ASTRONOMICAL INSTRUMENTS), though we have statements of ancient historians that observations quite as ancient were made by the Chaldeans. The dials commonly used in China are mentioned by Mohammedan travelers in that country in the ninth century.

After all this, it seems idle to quote the saying of Pliny, that the sun-dial was originally invented by Anaximander of Miletus (550 B. C.) ; but that curious writer, to whose appetite for information we owe so much, felt bound to give an origin for everything. He might even have read in Homer (950 B. C.), the not very recondite reference to a sun-dial : —

> "These curious eyes, inscribed with wonder, trace
> The sun's diurnal and his annual race."

The building in Athens long known as the "Tower of the Winds" is now known as the "Horological Monument of Andronicus Cyrrhestes." It had eight faces, each provided with a gnomon and divisional markings.

The dial in the square court of the Alexandrian Museum was visited by an august procession of philosophers during the seven centuries which separated Aristarchus from Hypatia. On the instrument, which had a plane parallel to the equator and a gnomon parallel to the earth's polar axis, Hipparchus, 150 B. C., learned the length of the year, that the four quarters of the year are not of equal length, and also observed the precession of the equinoxes. See ARMILLARY SPHERE.

Before the time of the erection of a sun-dial in the Quirinus by L. Papyrius Cursor, 293 B. C., the time was called by watches, which divided the time between the rising and setting of the sun. About thirty years after, the Consul Marcus Valerius Messala brought to Rome a dial from the spoils of Catania, in Sicily, and this he placed on a pillar near the rostrum; but, not being calculated for the latitude of Rome, it was inexact.

The obelisk erected by Augustus in the Campus Martius was brought by his orders from Egypt. It was originally hewn for Pharaoh Sesothis, according to Pliny, and was 76¾ feet in hight. After being long buried in ruins, it was disinterred but not re-erected by Pope Benedict XIV., and was found to be broken. Pliny states that in its position in the Campus Martius it was "applied to a singular purpose by the late Emperor Augustus, that of marking the shadows projected by the sun, and so measuring the length of the days and nights. With this object a stone pavement was laid, the extreme length of which corresponded exactly with the length of the shadow thrown by the obelisk at the sixth hour (noon) on the day of the winter solstice. After this period the shadow would go on day by day, gradually decreasing, and then again would as gradually increase, corresponding with certain lines of brass that were inserted in the stone; a device well deserving to be known, and due to the ingenuity of Facundus Novus, the mathematician."

On an ancient bas-relief at Rome, an hour-glass is placed in the hands of Morpheus, and Athenæus says that the ancients carried portable hour-glasses with them as measurers of time.

The ancients had three time-measurers, — dials, hour-glasses, clepsydras. Alfred the Great added wax tapers; perhaps Ebu Junis the pulsating lever; Galileo and Huyghens the pendulum. See CLOCK.

The Spaniards found the Mexicans provided with sun-dials for determining the hour, and instruments for the solstices and equinoxes. Their day had sixteen hours, commencing at sunrise. The Peruvians had also their sun-dials. One in Quito, in the form of an obelisk in the center of a circle on which was marked an east and west line, indicated the equinox. These were destroyed by the ignorant Spaniards, who thought them idolatrous. Their ancestors had stared with the same stupid amazement at the Saracenic armils and observatories.

Dials were placed in the gardens of the Tuileries and Luxembourg, so arranged as to fire a cannon at noon. A mortar is placed on the meridian line of the dial, with a burning lens placed over the touch-hole at such a distance and angle that as soon as the sun arrives on the meridian its rays, concentrated by the lens, set fire to the powder, the explosion of which announces the hour of noon.

> "We take no note of time but from its loss;
> To give it then a tongue is wise in man."

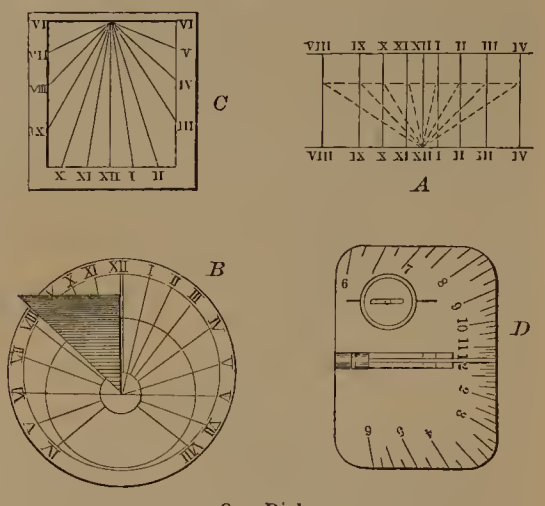
The voice is rather more energetic than anything which melancholy Young had probably anticipated or would enjoy.

Dials are of various construction, according to the presentation of the plane of the dial.

The *polar-dial* (*A*) has a plane parallel to the axis of the earth and perpendicular to the meridian of the place. In this case, the style is parallel to the plane of the dial, and the hour-lines are parallel straight lines, whose distances from the meridional line are respectively proportioned to the tangents of the angles which the hour-planes make with the plane of the meridian.

The *common dial* (*B*) has a horizontal plane, and makes with the style an angle equal to the latitude

Fig. 1626.



Sun-Dials.

of the place, the style preserving its parallelism to the earth's axis. This becomes a *polar dial* at the equator, as the plane of the dial is also parallel to the earth's axis. At other latitudes, the hour-lines intersect each other in the point in which the style interseets the plane of the dial. The angles which the hour-lines make with each other and with the meridional line cutting the XII depend upon the latitude.

The *vertical dial* (*C*) has a plane fixed to a wall, tower, or house. The determination of the hour-lines is similar to the case of the horizontal dial, but the angle formed by the gnomon and dial-plane is the *complement* of the latitude, the style preserving its parallelism with the earth's axis as before.

Varieties of the vertical dial are found with those having presentations east, west, etc. When the plane is east or west, it is in the meridian, is parallel to the vertical plane of the style, and the hour-lines are all parallel.

When a wall dial is not perpendicular, it is said to be *declined.*

When it does not face directly one of the four cardinal points, it is called a *vertical declined dial.*

The dial shows *true* or *solar* time, and not the *mean* time of a well-regulated clock. The dial agrees with such a clock four days in the year.

An *azimuth dial* has a style perpendicular to the plane of the horizon, and marks the sun's azimuth.

The pocket sun-dial (*D*) has a little compass for adjustment, and, of course, is only moderately exact even at its calculated latitude.

2. The graduated and numbered face-plate of a watch or clock. A *dial-plate.*

Fig. 1627.

Chinese Clock-Dial.

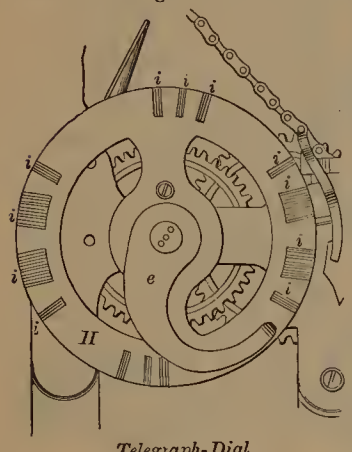
The old Chinese dials, like the divisions of the clepsydra, were decimally divided. The duodecimal division is later than Kung-futze.

The dial (Fig. 1627) is a suggestion for one

for the Chinese market; the outer circle has numerals corresponding to Roman numerals. The inner circle has the Chinese horary characters for the periods of two hours each, as they do not indicate these by numbers. The small intervening figures of the inner circle divide the two-hour periods into hours. The index finger or hand makes one revolution in twenty-four hours.

3. (*Telegraphy.*) An insulated stationary wheel having alternating conducting and non-conducting portions against which the point of a spring key is in frictional contact. To the wheel *H* one of the wires of the battery is attached, and the other wire to the axis of the spring-key *e*, whose pointer rests on the wheel. As the key rotates, while it passes over the metallic portion of the wheel, the circuit is complete, and when it passes over the non-conducting portions *i i* of the wheel the circuit is broken. Thus are signals given in Farmer's fire-alarm telegraph.

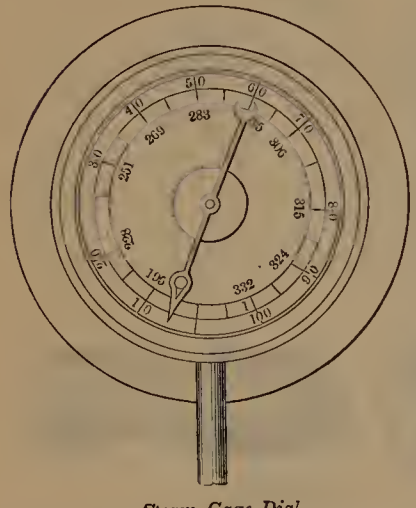
Fig. 1628.



Telegraph-Dial.

Another form of telegraph-dial is the lettered and number dial of the Cooke and Wheatstone telegraph, in whose center a pointer rotates or oscillates, and directs attention of the observer to the letters, which are spelled *ad seriatim* by this means.

Fig. 1629.



Steam-Gage Dial.

4. A circularly graduated plate on which an index-finger marks revolutions, pressure, or what not, in a register, counter, or meter. The cut shows a steam-gage dial which has two graduated circles, one representing pressure, the other temperature.

5. An instrument for holding the *dop* on the end of which the gem is cemented while exposed to the lap or wheel. It has adjustments as to inclination, and also axial, with markers indicating degrees in adjustment, so as to portion out the circumference of the stone in facets forming chords of specific arcs at given depths. See ANGULOMETER.

Di'al-lock. A lock provided with one or more dials, having a series of letters or figures on them. Each dial has a hand or pointer connected by a spindle with a wheel inside the lock; on the wheel is a notch which has to be brought into a certain position before the bolt can be moved. There are false notches to add to the difficulty of finding the true notch in each wheel. To adjust the notches to their proper position, a nut on the back of the wheel is loosened, and the pointer is set at any letter or figure chosen by the user. See PERMUTATION-LOCK.

Di'al-plate. (*Clock.*) The face on which the divisions indicating the hours and minutes are placed.

Di'al-wheel. (*Horology.*) One of those wheels placed between the dial and pillar plate of a watch. Also called *minute-wheel works.*

Di'al-work. (*Horology.*) The motion work between the dial and movement plate of a watch.

Di'a-mond. 1. (*Printing.*) A small kind of type used in English printing: —

Diamond, 205 ems to the foot.
Pearl, 178 ems to the foot.

2. A *lozenge* or *rhomb.* The name is conferred upon nuts and bolt-heads of that form. Also upon gravers which are rhombal, and not square in cross-section.

3. A valuable gem, the hardest of all, and of various colors. It has many uses in the mechanic arts, derived from its extreme hardness; some uses in optics, owing to its high refractive and small dispersive power. Sp. gr. 3.521.

Among the celebrated diamonds may be noted the following: —

Great Mogul. Found in 1550, in Golconda, and seen by Tavernier. Weighed 793 carats; cut to 279 carats (carat, 4 grains).

Russian. Taken from a Brahminical idol by a French soldier; sold to the Empress Catherine for £90,000 and an annuity of £4,000. Weighs 194 carats.

Pitt. Brought from India by Mr. Pitt, the grandfather of the first Earl of Chatham; sold to the Regent Duke of Orleans, in 1717, for £135,000. Weighed when rough, 400 carats; cut to 136½ carats. Napoleon placed it in the hilt of his sword.

Koh-i-noor. Seen by Tavernier in 1665, in the possession of the Great Mogul. Seized by Nadir Shah, in 1739, at the taking of Delhi. Became the property of Runjeet Sing. Captured by the English at the taking of the Punjab. Presented to the Queen by the East India Company, in 1850; weighed in the rough 800 carats, cut to 186$\frac{1}{16}$ carats; recut to 103$\frac{3}{4}$ carats. — BRANDE.

Austrian. A rose-cut diamond of 139½ carats.

Sir Isaac Newton suggested that the diamond is combustible, but the first to establish the fact were the Florentine Academicians, in 1694; they succeeded in burning it in the focus of a large lens. Lavoisier, in 1772, examined the results of combustion, which showed it to be pure crystalline form of carbon.

The uses of the diamond include the following: —

Abradant for various purposes, in wheels, laps, and slicers.

Stone drilling and sawing. See CARBON TOOL-POINTS.

Engraver's ruling, and marking graduations on instruments.

Glass-cutting. Lenses. Jewelry.

Di'a-mond-cut'ter's Com'pass. (*Diamond-cutting.*) An instrument used to measure the inclination of the sides of jewels. It is a movable arm *a*, inserted at an angle of 45° into a metallic base *b*. It is shown in the lower illustration of Fig. 1630 as measuring the inclination of the *collet-side* to the *girdle* and the *bizet* to the *table.* See BRILLIANT.

Di'a-mond-cut'ting. Until 1476, when Louis de Berghem, of Bruges, first discovered this art, the diamond was worn uncut; the four great stones in the mantle of Charlemagne furnishing an example.

The diamond is cut in three forms, the BRILLIANT

(which see), the rose, and the table, and their respective values are in the order named. The form a diamond shall assume is determined by its shape in the rough, the duty of the lapidary being to cut it so as to sacrifice as little as possible of the stone and obtain the greatest surface, refraction, and general beauty. Having decided upon the form, a model is made in lead and kept before the workman as a copy. The rough diamond is cemented to a handle called a *dop* (*a*, Fig. 1630), leaving the part exposed which is to be removed to form one facet. The projecting portion is then removed by attrition against another diamond similarly set in a handle (*B*, Fig. 1630), or by means of diamond-dust and oil upon a disk, wheel, or wire, according to circumstances. When a facet is finished, the stone is reset in the

Fig. 1630.

Diamond-Cutting.

handle and the process repeated. Several months are expended in cutting large stones, as the work proceeds very slowly.

The polishing is performed upon a rapidly revolving iron wheel *d*, driven by a band *g*, and fed by hand with diamond-dust and oil (*C*, Fig. 1630). The diamond is set in a dop as before, on the end of a weighted arm *f e*, and held against the wheel; the results of the process being collected in a box for future operations.

The weight of a diamond is expressed in carats equal to four grains; the term is derived from the Arabic *qirat*, a bean, a word derived from the Greek *keration*, signifying *a little horn*, the fruit of the karob-tree.

The value of a diamond is commonly increased threefold by skillful cutting, and its value is the square of its weight expressed in carats multiplied by $40 specie. This is but an approximation to the truth, for the value of diamonds fluctuates like other things, though to a less extent.

Diamonds with flaws or imperfections are sawn asunder or split; the latter (shown at *A*) being a speedy but risky operation, requiring great judgment in determining the plane of cleavage and skill in the use of the chisel *b* and hammer. For sawing, a fine wire is used, fed, as in the case of the revolving-wheel, with diamond-dust and oil.

Diamonds are of various colors. They are crystallized carbon, which, not color, determines the chemical difference between the diamond and other gems, such as the ruby, amethyst, topaz, etc., while its hardness expresses its mechanical difference.

Di'a-mond-draft. (*Weaving.*) A method of drawing the warp-threads through the heddles.

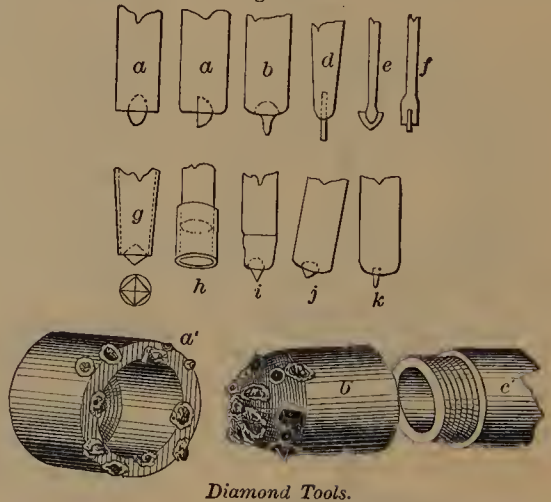
Di'a-mond-drill. A drill armed with a diamond, which cuts its way into the material as the drill-stock is rotated. It was invented by Hermann, and patented in France by him, June 3, 1854. He states that he makes crystals or angular fragments of the black diamond useful in "working, turning, and polishing, etc., of hard stones such as granite, porphyry, marbles, etc." The diamond is broken to obtain angular fragments, which are embedded by alloys in the metallic stock, to form a cutting-tool (*b' c'*, Fig. 1631). See CARBON TOOL-POINTS, p. 461.

In his certificate of addition, March 31, 1855, he states that the diamonds are to be inserted in holes drilled for them in the end of the drill-rod, the metal being battered down around them to form a bezel.

The drill-bar slides vertically, and is rotated by bevel-gearing. He refers to the need of water on the drill.

Leschot in 1860–64, and Pihet, in 1866, devoted some care to the matter; the latter introducing

Fig. 1631.



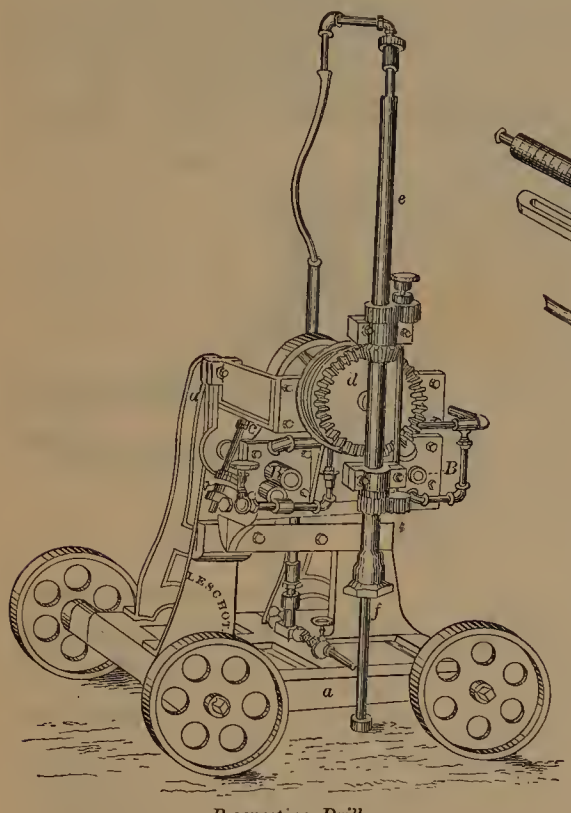
Diamond Tools.

the annular drill-head (shown at *a'*, Fig. 1631), which is a steel ring studded with black diamonds. The heads of the drills used at the Mont Cenis Tunnel, and the excavations by General Newton at Hallet's Point, East River, N. Y., were of this character.

Fig. 1632 represents a prospecting or open-cut drill detached from the boiler which drives it. The two oscillating engines *c* drive the bevel-gearing *d*, which rotates the drill-bar *e f* from 900 to 1,000 revolutions per minute, boring in ordinary rock from 15 to 20 feet per hour. *a* is the frame, *B* the steam connections.

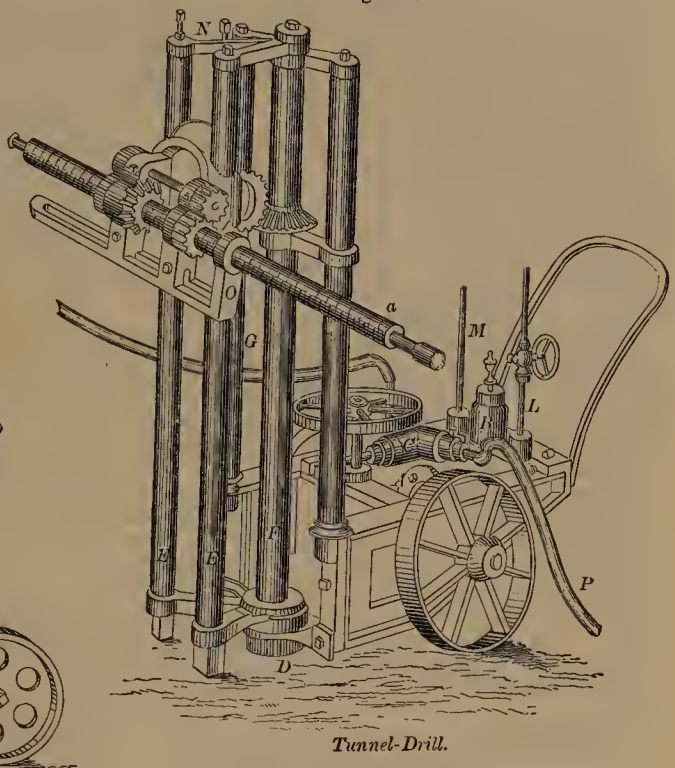
Fig. 1633 is a mining or tunnel drill. The upright frame *E E*, which supports the swivel drill-head with its gears and drill, is attached by hinge-

Fig. 1632.



Prospecting-Drill.

Fig. 1633.



Tunnel-Drill.

plates to the top and bottom of the driving-shaft *F*, and may be swung to the right or left, describing a semicircle. This allows the drill to act at any angle of the horizontal arc thus described without moving the machine. The drill-head also slides up and down this adjustable frame *E E*, enabling it to bore a perpendicular row of horizontal holes.

The drill itself, with its feed-gears and sliding-guide *O*, may be turned completely round by loosening a nut on the back of the swivel-head so that the point of the drill shall describe a vertical circle, at any angle of which it will bore equally well.

The two uprights *G G* used to support the driving-shaft *F* are made of common hydraulic pipe, and may be lengthened or shortened according to the hight of the tunnel. The driving-shaft *F* has a sliding-gear attached by feather and spline, adjustable at any position. The sliding brace just beneath this gear is used to steady the driving-shaft. Motion is communicated to this shaft by means of the gear *D*. The posts *E E* are set firmly against the upper wall by means of extension-screws *N N*, which may be run up two or three feet if desired. The steam or compressed air is brought through rubber hose from any convenient distance, and introduced into the engine by pipe *L*. *M* is the exhaust-pipe. The feed may be varied at pleasure, and according to the hardness of the rock from 90 to 340 revolutions per inch ; that is, from 2 to 10 inches per minute. The machine is balanced on its axle by depressing the handles *H*, and trundled about like a wheelbarrow. Operated by either compressed air or steam.

In Fig. 1631, *a a* are front and side views of diamond-chisels used in turning rubies for watch-jeweling.

b is a diamond-drill for making the hole in the ruby plate.

d is a tool of steel wire to be used with diamond-dust in drilling jewels.

e f are two views of a triangular fragment of diamond mounted for drilling china or porcelain.

g is a square stone mounted for the same purpose.

h is a metallic tube for drilling annular holes in jewels with diamond-dust.

i is a diamond-point mounted for etching or ruling in engraving.

j k are diamonds mounted for ruling graduations of mathematical instruments.

Di'a-mond-gage. Employed by jewelers in estimating the sizes of small diamonds. In the staff are set small crystals of graduated sizes by which jewels are compared. The crystals are from $\frac{1}{4}$ to $\frac{1}{64}$ of a carat.

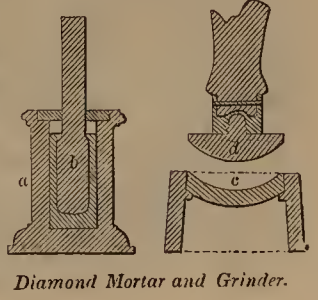
Di'a-mond-head'ed Bolt. See Bolt. A bolt whose head has a *lozenge* or rhombal shape.

Di'a-mond-knot. A kind of knot made at equidistant intervals on a rope, to give support to the hand or foot.

Di'a-mond-lens. The diamond-lens, owing to its high refractive and small dispersive power, requires much less curvature than glass lenses of the same focal length. It therefore admits of the employment of a larger pencil of rays, and gives more light. A diamond and a plate-glass lens of similar form and radius are in their comparative magnifying-powers as 8 is to 3.

Diamond lenses were made by Andrew Pritchard in 1824. One was recently made in London at a cost of £250 sterling.

Fig 1634.



Diamond Mortar and Grinder.

Di'a-mond-mor'tar. Diamonds for the use of the lapidary are crushed in a mortar, which consists of a cylindrical box *a* and a pestle *b*, both made of hardened steel. A small rough diamond is placed in the mortar, and the

pestle driven down by a hammer. The pieces of broken diamond are examined for the detection of fragments suitable for gravers, drills, and etching-points. The remainder is mashed to an impalpable powder by several hours' continued work, rotating the pestle between blows.

When sufficient fineness is not attained by the mortar, the dust may be ground between the concave and convex surfaces *c d* of a hardened steel mill, a little oil being added to the dust. The particles will grind each other.

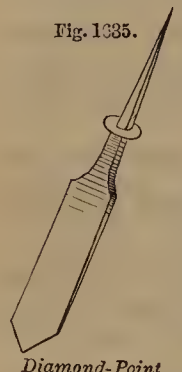
Di'a-mond-nail. A nail having a rhombal head, used for some purposes. The acute angles of the rhomb are sometimes made to clinch.

Di'a-mond-plow. A small plow having a mold-board and share of a diamond shape; that is, rhomboidal. One side of the rhomb runs level on the ground, another forms the breast, and the other two are the marginal lines of the backward extension of the mold-board.

Di'a-mond-point. A stylus armed with a diamond, either ground conical or made of a selected fragment of the desired shape. Wilson Lowry introduced the diamond-point into engraver's ruling-machines. Etching-tools have been pointed with diamonds. Diamond-points are used in ruling the graduation of the finer kinds of instruments, also by Nobert, it is supposed, in ruling the wonderful series of lines that form the tests of the microscopes of higher powers.

Di'a-mond-point Chis'el. A chisel whose corners are ground off obliquely.

Fig. 1635.



Diamond-Point Chisel.

Di'a-mond-tool. (*Metal-working.*) A metal-turning tool whose cutting edge is formed by facets.

Di'a-mond-work. (*Masonry.*) Reticulated work formed by courses of lozenge-shaped stones, very common in ancient masonry.

Di'a-pa'son. (*Music.*) A stop of an organ having pipes or reeds extending throughout the scale of the instrument.

Diapason-stops may be *open* or *stopped*, as the pipes are open above or are closed by *tompions*. *Double-diapason* is an octave graver than *diapason*. See STOP.

Di'a-per. 1. (*Fabric.*) A linen toweling with a small figure thrown up, as in damask.

2. A panel or flat recessed surface covered with carving or other wrought work in low relief.

Di'a-per-work. (*Masonry.*) A pavement checkered by stones or tiles of different colors.

Di'a-phane. (*Fabric.*) A woven silk stuff with transparent and colored figures.

Di'a-pha-nom'e-ter. An instrument for measuring the transparency of the air.

Di'a-phan'o-scope. (*Optics.*) A dark box for exhibiting transparent pictures with or without a lens.

Di'a-phan'o-type. (*Photography.*) Another name for the *hellenotype*, in which a diaphanous or pale positive on a paper rendered translucent by varnish is colored on the back and placed over and in exact correspondence with a duplicate positive of strong character.

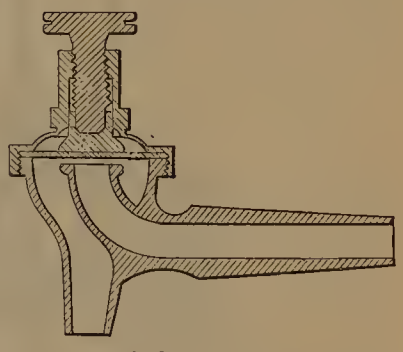
Di'a-phragm. 1. A partition in a chamber, tube, or other object.

Flexible diaphragms are used in steam-pressure indicators, faucets, gas-regulators, pumps, etc.

2. (*Optics.*) An annular disk in a camera or telescope, or other optical instrument, to exclude some of the marginal rays of a beam of light. The original form of this beautiful contrivance is the iris of the eye, which shuts out strong light and regulates the quantity admitted. The use of the iris was known to Leonardo da Vinci.

Di'a-phragm-fau'cet. One which closes its aperture by the depression of the diaphragm upon the end of a pipe by means of a screw-plunger.

Fig. 1636.



Diaphragm-Faucet.

Di'a-phragm-plate. A plate beneath the stage of a compound microscope, to restrict the amount of light reflected from the mirror. The plate has a number of holes of varying sizes, either of which may be brought to bear.

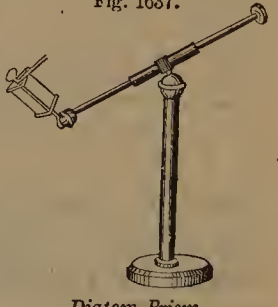
Di'a-phragm-pump. A pump in which a disk-piston is attached by an elastic diaphragm, usually of leather, to the sides of the barrel. It was described by Desaguliers in 1744 as "a piston without friction." It is much older than the time of this philosopher, however. It has been again and again re-invented, and brought out with a flourish of trumpets. See BAG-PUMP. Its application may have been suggested by the human diaphragm.

Di'as-tim'e-ter. A philosophical instrument for measuring distances.

Di'a-style. (*Architecture.*) A system of columniation in which the width of the intercolumns is equal to three diameters of a column.

Di'a-tom-prism. (*Optics.*) A triangular prism used for illuminating small objects in the field by oblique light.

Fig. 1637.



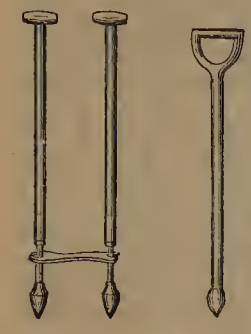
Diatom-Prism.

Di-at'o-ni. Angle-stones in a wall, wrought on two faces, and projecting beyond the general face of the wall.

Dib'ble. A pointed implement with a spade-handle used to make a hole in the ground to receive seed. In the East of England wheat-crops are put in by this means. It is slow, but sure. A man takes a dibble in each hand, and goes backward across the field; children following him drop the grains into the holes. It is economical of seed, but the principal motive is to condense the soil around the seed, so that it may retain moisture in that sandy country which once was a rabbit-warren, and where a certain duchess told the proprietor, Coke of Norfolk, that she saw two rabbits quarreling for one blade of grass.

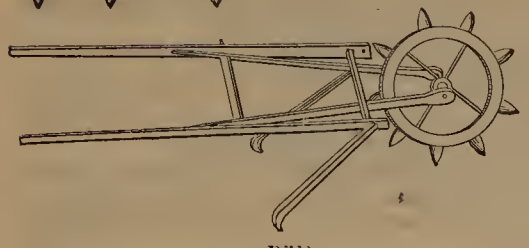
Dib'bling-ma-chine'. One used for making holes in rows for potato sets, for beans, or other things which are planted isolated in rows. It may be adapted for corn by instituting the proper proportion between the parts; corn requiring a greater distance apart in the rows, unless it is only to be tended one way. The machine shown is adapted to be pushed by one man, and may be a useful adjunct to gardening.

Fig. 1638.



About 1649, Gabriel Platte described a *dibbling-machine* formed of iron pins, "made to play up and down like virginal jacks."

Dice. Cubes with marked sides, thrown from a box and used in gaming or determining by chance. The dice of Thebes were cubical, and numbered like the modern, as may be seen by the figure which represents ancient dice in European museums.



Dibblers.

Dice are referred to in several places in the "Rig-Veda," the most ancient of the Sanscrit religious books: —

Fig. 1639.

Ancient Egyptian Dice.

"Let man fear Him who holds the four dice, before He throws them down." — *Rig-Veda*, I. 41, 9 (B. C. 1500).

Rhampsinitus is said by Herodotus to have played with the goddess Ceres, and Mercury is fabled to have played dice with the moon, winning from her the five odd days of the year.

The game of checkers also was played by Rameses, with two sets of men or dogs (*latrunculi*), or counters (*calculi*), of different colors. See CHECKERS.

While the statement of Herodotus possesses a certain historic interest, we cannot credit that dice, knuckle-bones, and ball were invented by the Lydians to while away the alternate days of fasting to which the people were subjected in a time of bitter scarcity. Neither can we credit Socrates when he avers that Palamedes, son of the King of Eubœa, invented dice to serve instead of dinner during the siege of Troy, 1200 B. C.

"Herodotus is mistaken when he says that these sports were invented in the time of Atys, to amuse the people during the famine, for the Heroic times are older than Atys." "In Homer the suitors amused themselves in front of the door with dice [to determine by the chances who should claim Penelope]." — ATHENÆUS, A. D. 220.

Plato is more probably correct in ascribing them to the Egyptians, though the Sanscrit book is as old as the Pentateuch and the Pharaoh who knew Joseph.

The Greek dice were cubes, and were numbered like our own, 6 – 1, 5 – 2, 4 – 3, so that the opposite faces should add 7. They usually threw three dice. The original dice are supposed to have been knuckle-bones, and they still maintained their popularity after the more perfect numbered cube had been introduced. The bones were called *tali*, and were used five in number. The *astragali* were probably cubes without numbers, and played like the knuckle-bones; they were made of bone, stone, metal, ivory, or glass. The number of pieces used was similar to the number of the lines on the Greek *abacus*, or the digits of the hand. (See ABACUS.) The game of *astragali* is represented in ancient sculpture and in a painting in Herculaneum. Pliny mentions a group in bronze by Polycletus of two naked boys at play, then in the Atrium of Titus. The same subject in stone is in the British Museum.

In the game of *duodecim scripta* the moves were determined by dice; the game of *tali* and *tessera* was played with dice. Dice similar to ours were found at Herculaneum, and the convulsion which overwhelmed Pompeii surprised a hazard-party at their amusement; 1800 years afterward the dice were found in their bony hands, and the game yet unsettled.

At an entertainment given in 1357 by the Lord Mayor of London, the Kings of France and Scotland being prisoners and the King of Cyprus on a visit (*temp.* Edward III.), the host challenged all to dice and hazard. — STOW.

The dice-box of the ancients (*fritillus*) was of a cylindrical form, and had parallel indentations to turn the dice as they were shaken.

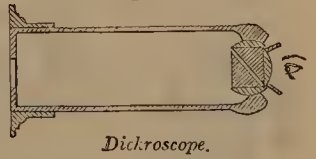
To descend one step lower brings us down to the game of "odd and even" (*par et impar*), a puerile amusement played by the Roman vagabonds with beans, nuts, almonds, or coin. It was played with the fingers in ancient Egypt, in Greece, and in Rome, and still survives in the Mexican *mora*.

Pitch and toss was not so common, but pitching coins or bones within a ring or into a hole was common in ancient Greece.

Thimble-rig was understood and practiced by the ancient Egyptians, much as by the vulgar of the present day. It consisted of four inverted cups hiding an object, such as a pea or other "little joker," and is described by Kenrick and Wilkison.

Di'chro-scope. (*Optics.*) An instrument to exhibit the two complementary colors of polarized light. The quality called the dichroism of crystals consists in transmitting different colors when viewed in different directions. There are several varieties of this apparatus invented by Arago and Brewster.

Fig. 1640.



Dichroscope.

As constructed by Brewster, it consists of a tube about two inches long, blackened on the interior, and attached to a ball and socket.

The ball contains two prisms of calcareous spar, separated by a film of sulphate of lime, so placed that each pair of the four images is tinged with the complementary colors. A lens is arranged upon or near the prisms either at front or back.

On viewing the sky or any luminous object, four brilliantly colored images of the aperture will be seen, the color of the two middle ones being complementary to that of the outer ones. By moving the ball in the socket the colors will constantly change, and the images will sometimes overlap and sometimes separate, exhibiting a great variety of hues, pleasing the eye by their combinations and by the soft harmony of their contrasts.

Many beautiful variations may be obtained by using several films of sulphate of lime having their axes variously inclined to one another.

For other forms of this instrument see "Encyclopedia Edinensis," Vol. XV. pp. 653, 654, and plate ccccxlii.

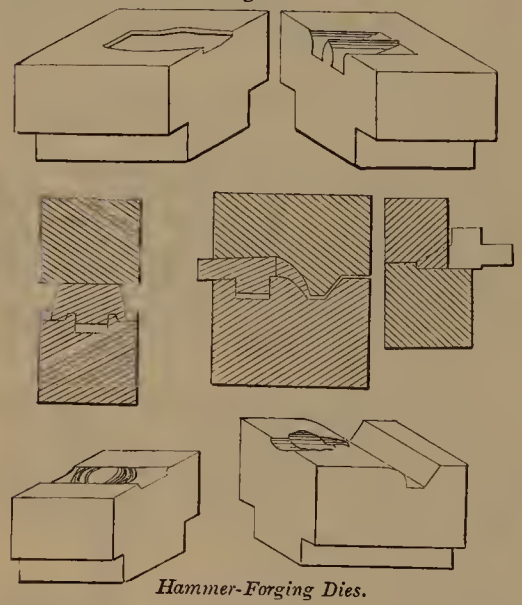
Dic'ing. A mode of ornamenting leather in squares or diamonds by pressure, either of a blunt awl or an edging-tool, or in a machine by pressure between dies.

Dick'ey. A seat behind the body of a carriage for servants. In the old-fashioned English stage-coach it was occupied by the guard and some passengers.

Die. 1. (*Metal-working.*) *a.* In punching-machines, a bed-piece which has an opening the size of the punch, and through which the piece is driven. This piece may be a planchet or blank, or it may be merely a plug driven out of the object to form a bolt or rivet hole. In nut-machines the nuts-blanks may be made by one die and punched by another.

b. (*Forging.*) A device consisting of two parts which coäct to give to the piece swaged between

Fig. 1641.



Hammer-Forging Dies.

them the desired form, as in the example (Fig. 1641), which shows a set of hammer-forging cameo and intaglio dies, which act successively upon the blank.

c. (*Sheet-metal.*) A former and punch or a cameo and intaglio die between which a piece of sheet-metal is pressed into shape by a blow or simple pressure. See DROP-PRESS.

d. (*Coining.*) Both dies are intaglio, so as to make a cameo or raised impression upon each face of the *planchet*. The upper die has the *obverse*, the *face*, which is often the bust of the sovereign or national emblem. The lower die has the *reverse*, with an effigy, legend, value, escutcheon, as the case may be.

Owing to the random way in which ornaments are disposed on coins, any general definition will no longer meet all cases.

A die for coining, mechanically considered, is made by the following process: A piece of softened steel called a *hub* is prepared, and upon its end the design is cut. The steel is then hardened, and is used to make a *matrix*, in which the impression is *intaglio*, that is, sunken. A plug of softened steel a little larger than its ultimate size, and with the center a little raised, is placed on the bed of a screw-press, and, the hardened matrix being placed upon it, pressure is brought to bear on the matrix, which delivers its impression on the face of the plug. The result is a salient impression,

Fig. 1642.

Coining-Dies.

and forms the *punch*. In all cases where metal is condensed it becomes heated and hardened, and in this case it becomes necessary to withdraw the imperfect *punch* and anneal it, after which it receives another pressure from the matrix. This is repeated until the impression is fully developed. The *punch*, by a similar operation, is then employed to make a *die*. The *die* is then hardened, and may be used for coining or for making a new *hub* if the former should become injured. The first perfect die is generally retained for the purpose last mentioned.

The date is put by hand into the *dies* to be used in coining, as it requires to be changed; and the first *die* and the *hub* may be preserved for many years and may make hundreds of *dies*. For the application of the *dies*, see COINING.

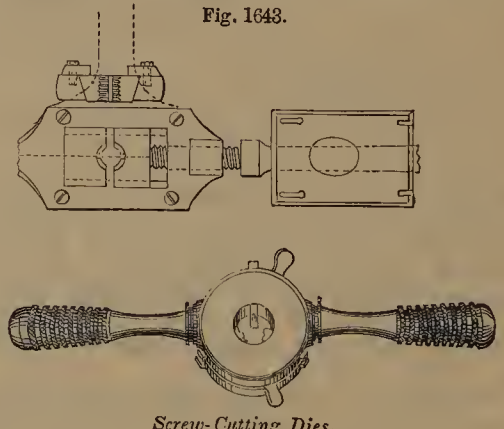
A mode of procedure which saves one step in the above process is to engrave the design in intaglio in the first place. This, when hardened, forms a *matrix*, from which the *punch* is made; the *punch* being used to form the *die* for coining.

A die will sometimes deliver 250,000 impressions before it is necessary to remove it from the coining-press; and sometimes a die will crack at the first impression.

e. (*Engraving.*) An engraved plate or small roller of steel, subsequently hardened and used to deliver an impression upon the surface of a soft steel roller, which in turn is hardened and forms a *mill*. The *die* is *intaglio*, and the *mill* is *cameo*. The latter is used to impress a plate or a roller to be used for bank-note printing or calico-printing respectively. See TRANSFERRING-MACHINE; CLAMMING-MACHINE.

f. One of the pieces which combine to form a hollow screw for cutting threads on bolts and such

Fig. 1643.



Screw-Cutting Dies.

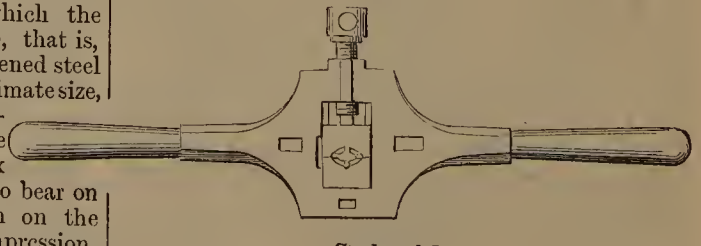
like. The two portions are fitted in a *stock*. In some, the dies are set up by screws, in others by scrolls.

2. The cube or dado of a pedestal.

3. A cube marked with figures on its respective sides and used in games of chance. See DICE.

Die-sink'ing. The art of making dies for coins, medals, etc. It is a branch of engraving, but in-

Fig. 1644.



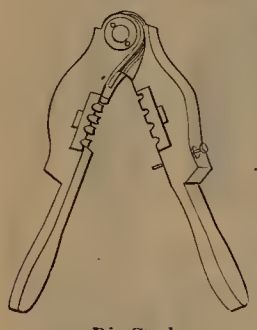
Stock and Dies.

volves turning, tempering, and the use of other tools besides the graver. See DIE.

Di'e-sis. (*Printing.*) The double-dagger (‡), a reference-mark.

Die-stock. A frame to hold the dies for cutting external screw-threads. The dies are detached pieces of steel, containing the thread on their inner curved surfaces, and these fit into grooves or upon ridges in the slot of the die-stock, being closed upon the bolt to be threaded by means of a set screw.

Fig. 1645.



Die-Stock.

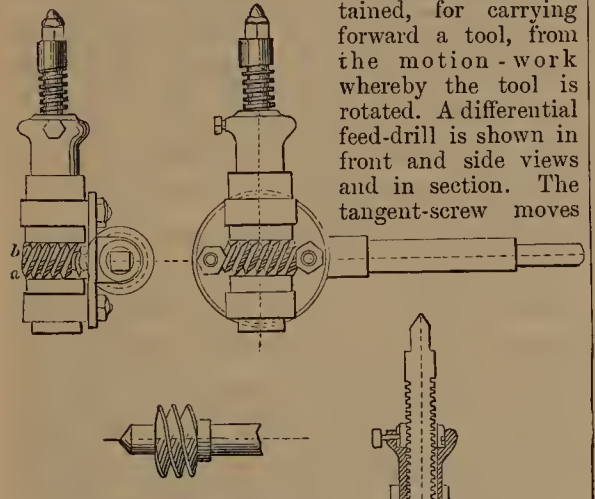
Plier die-stocks are made by setting removable dies in the jaws of pliers.

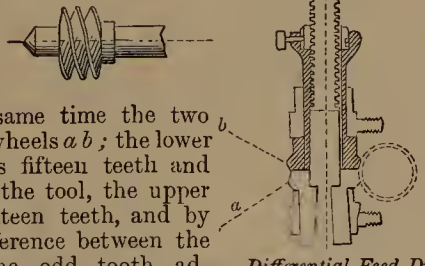
Diffe-ren'tial Block. A double block having sheaves of different sizes. See DIFFERENTIAL PULLEY.

Diffe-ren'tial Coup'ling. A form of extensible coupling, to vary the speed of the driven part of the machinery.

Diffe-ren'tial Feed. An arrangement by which a regular powerful and slow movement is obtained, for carrying forward a tool, from the motion-work whereby the tool is rotated. A differential feed-drill is shown in front and side views and in section. The tangent-screw moves

Fig. 1646.





Differential-Feed Drill.

at the same time the two worm-wheels *a b*; the lower one has fifteen teeth and rotates the tool, the upper has sixteen teeth, and by the difference between the two, the odd tooth advances the tool gradually by the rotation of the axial screw.

Diffe-ren'tial Gear'ing. A form of gearing first introduced by Dr. Wollaston in his *trochiometer*, for counting the turns of a carriage-wheel, in which two cog-wheels of varying sizes are made to travel at the same absolute surface-rate and in the same direction, and communicate motion equivalent to the difference between the circumferences of the two. See, for an illustration, DIFFERENTIAL FEED. See also EQUATIONAL-BOX.

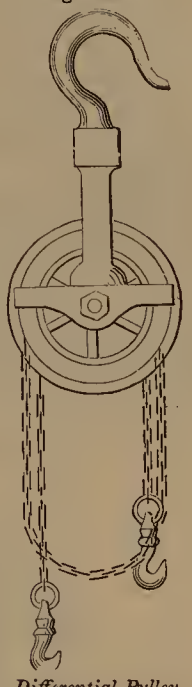
Diffe-ren'tial Pul'ley. This, in a somewhat clumsy form, has been known for centuries under the name of the Chinese windlass, and one was found by the allied English and French armies to be in use for raising one of the drawbridges in the city of Pekin. It was described by Dr. Carpenter in his "Mechanical Philosophy," etc., 1844.

The chain winds over two drums of different

Fig. 1647.

Differential Pulley.

Fig. 1648.



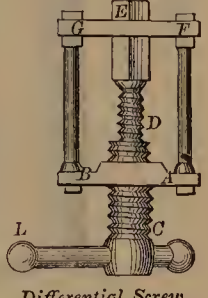
Differential Pulley.

diameters, winding on to one as it unwinds from the other; the effect gained is as the difference between the two, the smaller the difference the greater the power and the less the speed.

In the geared differential pulley the effect is produced by making one more tooth in one of the wheels the chain passes over than in the other.

Diffe-ren'tial Screw. Invented by Hunter, the celebrated surgeon. Two threads of unequal pitch are upon the same shaft, one unwinding as the other winds. The effective progression is equal to the difference of the pitches of the two threads. By making this difference very small, great power may be attained without the weakness due to a very fine screw.

Fig. 1649.

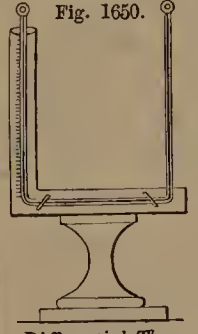


Differential Screw.

A B is a plate of metal in which the screw *C D* plays. This screw is hollow, and receives the smaller screw *D E*, which is free to move longitudinally, but is restrained from rotating by the frame *A F G B* of the press. The larger screw has ten threads to the inch, the smaller one has eleven.

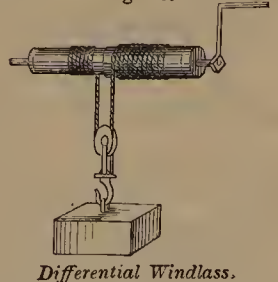
Diffe-ren'tial Ther-mom'e-ter. A thermometer having two air-bulbs connected by a bent stem occupied by colored sulphuric acid. When one leg

Fig. 1650.



Differential Thermometer.

Fig. 1651.



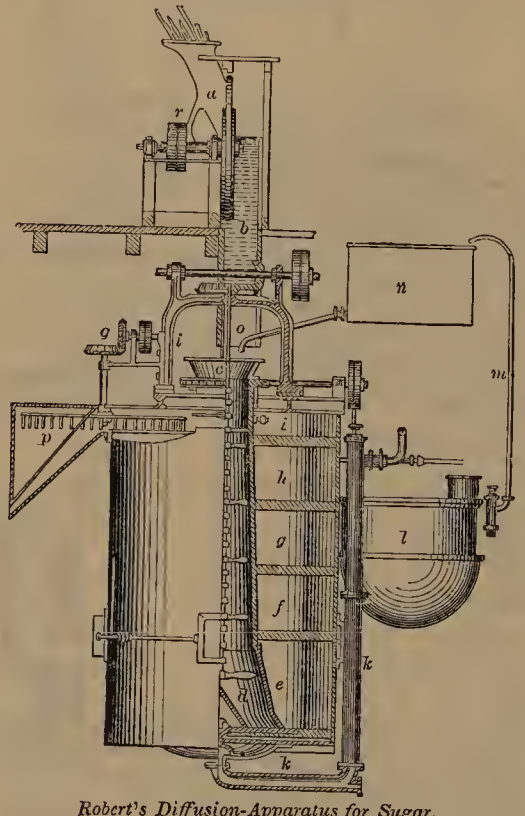
Differential Windlass.

is exposed to heat, the air in the bulb is expanded, and the liquid in that leg of the instrument is depressed.

Dif'fe-ren'tial Wind'lass. A windlass whose barrel consists of two portions of varying diameters. The rope winds on to one as it winds off the other, the effect of a revolution being governed by the difference between the circumferences of the two portions. If it wind on to the larger and off of the smaller the load is raised, and conversely. See CHINESE WINDLASS.

Dif-fu'sion-ap-pa-ra'tus. (*Sugar-manufacture.*) A mode of extracting the sugar from cane or beet-root by dissolving it out with water. It is adopted in some establishments in British India and in Austria. The sugar-yielding material is fed in at the hopper *a* and cut into slices in the cylinder *b* by knives driven by band-wheel *r*, and issues at the opening *o* into the hopper *c*, where it is carried down the central pipe *d* and discharged into the lower

Fig. 1652.



Robert's Diffusion-Apparatus for Sugar.

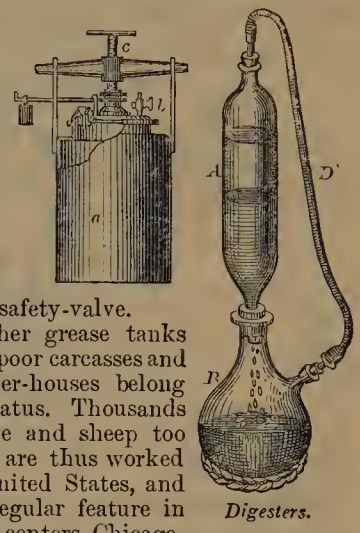
chamber *e*, and, gradually ascending through the series of chambers *f g h i*, is carried off by a rake *p* driven by gearing *q*. As the slices of cane rise in the diffusing-chambers, they meet water, which is supplied from above through small pipes, the water meeting first the most exhausted slices as they rise to the discharge-level, and passing through to the richer material as it becomes more and more saturated. At the bottom it issues through perforations or outlet-pipes *k*, and is carried off to a cistern *l*, where it is heated, and is then returned upon the cane through the pipe *m* and the cistern *n* and the central feeding-tube, by which the cane or beet is supplied to the diffusing-chamber.

Dif'fu'sion-tube. An instrument for determining the rate of diffusion of different gases. It consists of a graduated tube closed at one end by plaster-of-paris, — a substance which, when moderately dry, possesses the required porosity. — THOMAS.

Di'gest-er. Invented by Dr. Papin, about 1690.

A strong boiler *a* with a tightly fitting cover *b*, closed by a screw *c*, and used to expose food to a heat above 212°. By a certain increment of heat the gelatine is separated from the phosphate of lime of the bones; the earthy particles sinking to the bottom. It has a safety-valve on top to allow steam to escape when it begins to acquire a dangerous tension. It was in contriving this boiler that Dr. Papin invented the safety-valve.

Fig. 1653.



Digesters.

The lard and other grease tanks used for working up poor carcasses and the offal of slaughter-houses belong to this class of apparatus. Thousands of carcasses of cattle and sheep too poor for the market are thus worked up yearly in the United States, and the lard-tank is a regular feature in the hog-slaughtering centers, Chicago, Cincinnati, etc., where the entrails and other offal yielding grease are thus treated on a large scale.

The tanks have also been introduced into Buenos Ayres and probably into Texas, where beeves are slaughtered for their hides and tallow. The carcasses, after removing a few choice parts, are dumped into the tanks, when steam is applied, resolving them into fat, water holding soluble matters in solution, and mud, the latter containing the earthy and some other particles.

Of this class is Wilson's tank for rendering lard and tallow, patented in 1844. The tank is preferably a vertical cylinder, and is calculated for high-pressure steam. It has a perforated steam-pipe below the perforated false bottom which sustains the charge, and allows the water of condensation to percolate into the lower chamber. A discharge-hole at bottom is provided for removing the residuum. A number of try-cocks at different hights afford means for determining the levels of the fat and water respectively; and discharge-cocks permit the floating fat to be decanted or the water withdrawn, as the contents and state of the process may require.

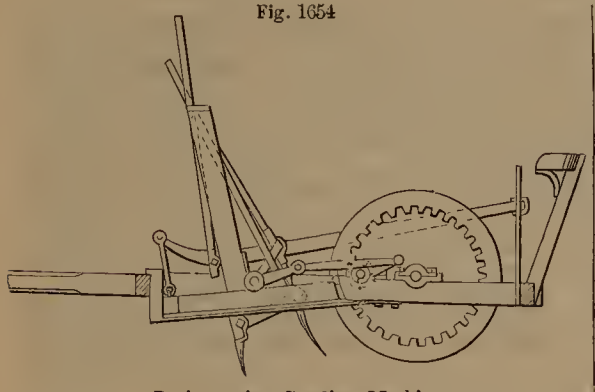
The figure on the right hand shows an apparatus in which tannin is extracted from the vegetable substances which yield it,—say, for instance, nut-galls. It is an elongated glass vessel *A*, having an orifice at top which is fitted with a ground-glass stopper, and contracting at its lower extremity so as to fit into the neck of a bottle or matrass *B*, which receives the extract. The matrass connects by proper orifices and a caoutchouc-tube *D* with the vessel *A*, so that the ether which lies upon the nut-galls in the upper vessel and forms the menstruum of the extract in the lower one shall not evaporate.

Dig'ger. A name applied to some forms of spade-like implements in which the soil is lifted and turned by other than the usual modes. More curious than useful.

Dig'ging-ma-chine'. (*Agriculture.*) A spading-machine for loosening and turning the soil. There are many forms, which may be classed under two heads, reciprocating and rotary.

Fig. 1654 represents one kind in which the spade-handles pass through guide-slots in an upper bar, and receive their motion by attachment to cranks revolved by connection with the drum. The depth

Fig. 1654

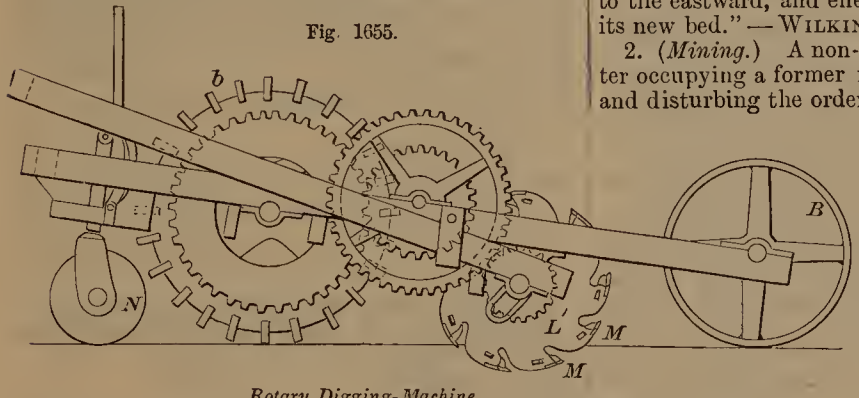


Reciprocating Spading-Machine.

is regulated by the vertical adjustment of the tilting-frame which carries the crank-shaft.

In the rotary machine (Fig. 1655) the ground-wheel *b* drives the spade-wheel *L'* through the intervention of gearing. The wheel *B* is in the advance, and the depth of penetration is regulated at the rear

Fig. 1655.



Rotary Digging-Machine.

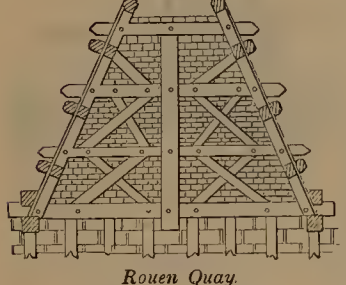
of the frame above the caster-wheel *N*. The shares *M M* are removable.

Other forms of spaders have blades thrust out and retracted as the machine advances.

Digue. A sea-wall or breakwater. An artificial construction opposing a barrier to the sea or preventing the denudation of the land thereby. See DIKE.

Dike. 1. A levee or wall of earth, gabions or carpentry, to prevent the encroachment of water, or to serve as a wharf or jetty.

Fig. 1656.



Rouen Quay.

The structures vary extremely, according to purpose, exposure, and the nature of the foundations. The more superior class consists of a timber structure strongly braced, founded on piles, filled in with stone, and faced with planking or masonry. See SEA-WALL; JETTY; BREAKWATER.

The dikes of Holland are the most memorable of their class, and protect from the sea that wonderful land which is so largely below the high-water sea-level. The dikes in some parts of Holland are thirty feet above the ordinary level of the country, and have sufficient width at top to form a roadway. They are founded on timbers and piles filled in with stones faced with clay and revetted with gabions of rushes, willows, etc. The slope to the sea is from 1 rise to 4 base down to 1 in 13.

The history of these works is one of gradually increasing strength and solidity, with heroism and pertinacity wonderful to relate. The accidents by which the sea has again and again claimed its own have swept away whole provinces and communities. A flood in 1277 formed the present Gulf of Dort and overwhelmed forty-four villages. The flood of 1287 overwhelmed 80,000 persons, and gave the Zuyder Zee its present bounds. Another storm in the sixteenth century destroyed 100,000 persons.

The Haarlem Lake is the latest of the great reclamations. The cost of rendering habitable and cultivable the 51,300 acres was $3,330,000, about $65 per acre. Previously to undertaking this colossal work, the Zind Plass, of nearly 11,500 acres, had been reclaimed at a cost of $1,250,000, not far from $110 per acre.

Among the most celebrated of dikes was that of Menes, which turned the Nile from its course to accommodate the new city of Memphis. "Its lofty mounds and strong embankments turned the water to the eastward, and effectually confined the river to its new bed." — WILKINSON.

2. (*Mining.*) A non-metallic wall of mineral matter occupying a former fissure in rock, intercepting and disturbing the order of ore-bearing strata.

3. A stone fence (Scotland).

4. A ditch for water.

Di-lat'or. An instrument for extending parts, such as the eyelids, or dilating the walls of a cavity, the urethra, vagina, anus, etc. See the following:—

Anal dilator.
Eyelid-dilator.
Lachrymal-duct dilator.
Speculum.
Sphincter-muscle dilator.
Stricture-dilator.
Urethra-dilator.
Uterine dilator.

Dil'i-gence. A French stage-coach. It was the national vehicle on the regular routes; had four wheeels, two compartments, a deck, and a dickey; was drawn by from four to seven horses, and engineered by a postilion.

Dil-lu'ing. A Cornish word for the operation of sorting ores in a hand-sieve. The sieve has a hair bottom of close texture, and contains about thirty pounds of stamped tin ore. The sieve is immersed in water and moves the ore up and down and circularly, so as to cause all the particles to be in a state of suspension in the water.

By inclining the sieve the lighter particles are allowed to run off into the *keeve*, while the richer particles are laid aside for *roasting*.

Di-lut'ing Rol'ler. A roller in paper-making machinery, which conducts an additional supply of water into the pulp-cistern to reduce its density.

Dim'i-ty. (*Fabric.*) A heavy, fine, white cotton goods, with a crimped or ridged surface; plain, striped, or cross-barred.

The Greek *dimitos* (double warp-thread) is believed to have been a kind of twilled fabric, and was equivalent to the Latin *bilix*.

Di'men-sion Lum'ber. Lumber sawed to specific sizes to order, in contradistinction to *stock-lumber* which has the usual market-sizes. See STOCK-GANG.

Di'men-sion Stone. Ashlar (which see).

Di-min'ish-ing-staff. (*Shipbuilding.*) Planking wrought under the wales, and thinned to correspond with the thickness of the bottom plank.

Ding-dong. (*Horology.*) A striking arrangement in which two bells of different tones are used and struck in succession to mark the quarter-hours.

Dinged-work. Work embossed by blows which depress one surface and raise the other. See CHASING.

Din'gy. 1. A row-boat of the Hoogly, which probably gave the name to the little jolly-boat of the merchant-service, mentioned below.

2. A boat of Bombay, propelled by paddles, and having one mast and a settee-sail.

3. An extra boat of a ship for common uses. It is clinker-built, from 12 to 14 feet long, and has a beam one third of its length.

Di-op'ter. An ancient altitude, angle, and leveling instrument; said to have been invented by Hipparchus. *Dioptra.*

Di-op'tric Light. The dioptric system of lighting, used in lighthouses, as distinguished from the catoptric, which is by reflectors. Refraction instead of reflection.

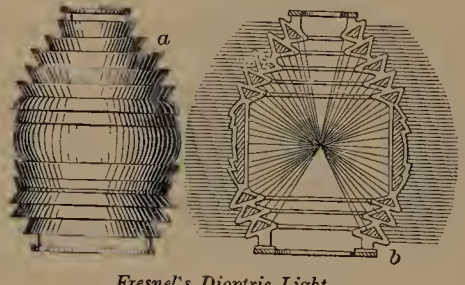
Lenses were used in the South Foreland light in 1752, and in the Portland light, England, in 1789. The system fell into disfavor, owing to certain mechanical difficulties in the construction and arrangement of the lenses.

It was revived and improved by Fresnel about 1810, and has been generally adopted throughout France and Holland, and partially in England. It is considered superior to the catoptric, and was readopted in England in 1834, being placed in the Lundy Island Lighthouse, Devonshire, England.

The Fresnel dioptric lamp consists of a mechanical, four-wicked oil-lamp, placed in the center of an octagonal glass prism; the center part of each of the sides being formed of a plano-convex lens of about 15 inches diameter, which is surrounded by a series of glass rings of a spherical triangular form, so as to produce the same effect upon the rays as is produced by the central lens. Allan Stevenson, Arago, and Faraday are credited with improvements in the details.

The flame is placed in the focus of the lenses, and the beams are bent parallel to each other, so as to form a solid beam of light proceeding from each

Fig 1657.



Fresnel's Dioptric Light.

lens. The lenses, after careful and persistent attempts, were merged into a cylindrical hoop which formed the central zone around the flame, as seen in the elevation *a*. The rays striking above and below were bent so as to assume a position parallel to those proceeding from the hoop, as seen in the section *b*.

Di-op'tric Mi-crom'e-ter. A form of the double image micrometer, introduced by Ramsden (1735-1800), in which the divided lens is in the eye-tube. In the ordinary form it is the object-glass which is divided.

Di'o-ra'ma. A mode of scenic representation in which the spectator and picture are placed in separate rooms, and the picture viewed through an aperture the sides of which are continued towards the picture, so as to prevent the distraction of the eye by other objects. All light admitted passes through this aperture from the picture, which is illumined by light from above at such an angle as to be reflected through the aperture towards the spectators. By means of shutters, screens, and reflectors, the light is modified to represent changes of sunlight, cloud, and moonlight. Transparent portions of the picture admitting light from behind brilliantly illuminated certain portions.

M. Daguerre was one of the artists of the dioramic exhibition at Regent's Park, London, in 1823. He is justly famous in connection with his heliographic discoveries. He died in Paris, January 10, 1851, aged 62. M. Bouton was associated with Daguerre in the invention and exhibition.

Dip. 1. (*Compass.*) The vertical angle which a freely suspended needle makes with the horizon. *Inclination.* See DIPPING-NEEDLE.

2. (*Mining Engineering.*) The inclination or pitch of a stratum. The point of the compass towards which it declines is the *point of dip.* The angle with the horizontal is the *amount of dip* or the *angle of dip.* The *strike* is the extension of the stratum at right angles to the *dip.* *Dip* is also known as *hade, slope, underlie.*

3. The depth of submergence of the float of a paddle-wheel.

4. A candle made by repeated dipping of the wick in melted tallow.

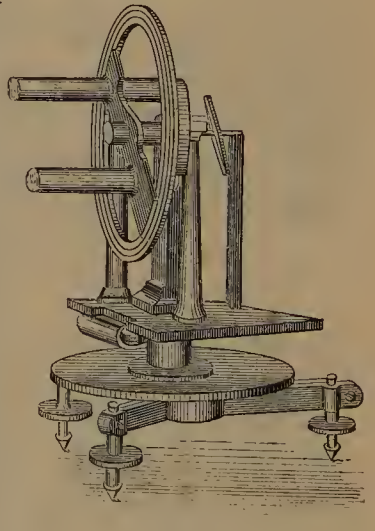
5. The slight downward inclination of the arms of an axle. *Swing.*

6. (*Fortification.*) *a.* The superior slope of a parapet.

b. The inclination of the sole of an embrasure.

Dip-cir'cle. A vertical graduated circle, in the plane of which a delicate magnetic needle is suspended on a horizontal axis, which rests upon two polished agate supports. The circle is set in the plane of the magnetic meridian, and the needle indicates upon the graduated circle the angle of inclination.

Fig. 1658.



Dip-Circle.

In the improved form shown at Fig. 1658, the needle is insulated from other metal, and the readings are effected by two telescopes fixed on opposite ends of an arm traversing a graduated circle.

Dip-head Lev'el. (*Mining.*) The gallery proceeding right and left from the engine-pit bottom. The *main*-level.

Di-plei'do-scope. An optical instrument for indicating the passage of a heavenly body over the meridian by the coincidence of two images formed by a single and double refraction from a triangular prism which has one transparent and two silvered planes, one of the latter being in the plane of the meridian. — BRANDE.

Dip'per. (*Photography.*) An instrument used

for immersing negative plates in upright baths containing nitrate of silver, hyposulphite of soda, cyanide of potassium, etc., and withdrawing the same after sensitizing or fixing. They are slender flat strips of hard rubber, wood, glass, porcelain, and sometimes silver wire, having short projections upon which to rest the edge of the plate, which stands nearly upright in the bath while the chemical changes take place.

Dip'ping. 1. The process of brightening ornamental brass-work.

a. The grease is removed by heat or lye.
b. The work is *pickled* in dilute aquafortis.
c. Scoured with sand and water.
d. Washed.
e. *Dipped* in a bath of pure nitrous acid for an instant.
f. Washed. *g.* Rubbed with beech sawdust.
h. Burnished. *i.* Lacquered.

2. Plunging sheet-iron plates in the pickle or the tin-bath in tinning.

3. Wicks in the tallow-vat.

4. The wool or fabric in the dye-tub.

5. The paper form in the pulp.

And so on of various operations in the arts, mechanic and fine.

6. The Scotch term for the *dubbing* of American and English curriers. It consists of boiled-oil, fish-oil, and tallow.

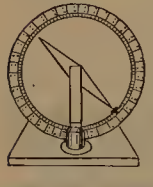
7. (*Photography.*) Immersing the collodionized plate in a sensitizing bath.

Dip'ping-frame. 1. A frame from which candle-wicks are suspended while dipping into the vat of melted tallow. See CANDLE.

2. (*Dyeing.*) A frame on which the fabric is stretched and immersed in dyeing with indigo.

Dip'ping-nee'dle. The inclination or dip of the magnetized needle was not known to the Chinese, who had discovered its variation during the twelfth century.

Fig. 1659.



Dipping-Needle.

This element of terrestrial magnetism appears to have been discovered by Robert Norman, a compass-maker of Ratcliff, London, who detected the *dip* and published the fact in 1576. He contrived the dipping-needle, and found the dip at London to be 71° 50′. See also DIP-CIRCLE.

Captain Sir James Ross, the celebrated Arctic navigator, reached the magnetic pole, latitude 70° 5′ 17″ north, and longitude 96° 46′ 45″ west, on the 1st of June, 1831. The amount of dip was 89° 59′. Horizontal needles refused to work, showing no sensitiveness. He erected a cairn of limestone rocks, inclosing a tin case containing the record. The cairn may remain, unless the Esquimaux Indians have removed it in search of plunder, but the magnetic pole has moved away.

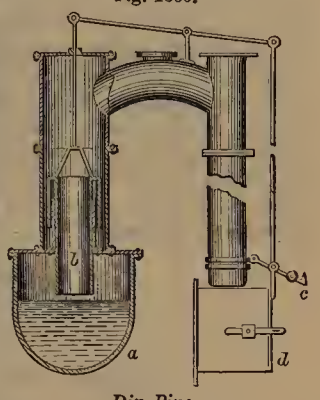
The dipping-needle is one of the instruments furnished to the chain of observatories which are dotted over the earth. See MAGNETOMETER.

Dip'ping-pan. (*Stereotyping.*) A square, cast-iron tray in which the *floating-plate* and plaster-cast are placed for obtaining a stereotype cast. The floating-plate is to form the back of the stereotype, and the mold the face; the dipping-pan forms the flask, and is plunged beneath the surface of the metal in an iron pot. The metal runs in at holes through the lid and forces apart the plate and mold.

Dip'ping-tube. A tube for taking microscopic objects out of a liquid. See FISHING-TUBE.

Dip-pipe. A device, also known as a *seal*, in the hydraulic main of gas-works. In the illustration, the seal-cup *a* is charged with tar, which permits the movable dip-pipe *b* to be lifted into or out of the main. The lid *c* cannot be removed from the mouthpiece until the handle is raised, which removes the lock and seals the dip. When the retort is again charged, and the lid fastened by bearing down the handle of the lift, the lid is locked and the dip is again raised.

Fig. 1660.



Dip-Pipe.

Dip-roll'er. (*Printing.*) A roller to dip ink from the fountain.

Dip-sec'tor. A reflecting-instrument. One was invented by Dr. Wollaston, and one by Troughton. It is used for ascertaining the true dip of the horizon; the principle is similar to the sextant.

Dip'ter-on. (*Architecture.*) A temple having a double row of columns on each of its four sides. Such an edifice is said to be *dipteral.*

Di-rect'ing-cir'cle. A ring used in giving the proper shape in making gabions.

Di'rect-ac'tion Steam-en'gine. A form of *steam-engine* in which the piston-rod or cross-head is connected directly by a rod with the crank, dispensing with working-beams and side-levers. They may be classed generally under three heads: those which obtain the parallelism of the piston-rod by means of the system of jointed rods called a *parallel motion*; those which use *guides* or sliding surfaces for this purpose; and those denominated *oscillating*-engines, in which the cylinder is hung upon pivots and follows the oscillations of the crank. More specifically as follows: —

Annular cylinder steam-engine (*Maudslay's*).
Double-cylinder steam-engine (*Maudslay's*).
Double-piston steam-engine (*Maudslay's*).
Gorgon steam-engine (*Seaward's*).
Inclined cylinder steam-engine (*Brunel's*).
Inverted cylinder steam-engine (*Galloway's*).
Inverted double-cylinder steam-engine (*Hick's*).
Oscillating cylinder steam-engine (*Witty's*).
Sliding-cover steam-engine (*Parkyn's*).
Steeple steam-engine (*Trevethick, Napier*).
Trunk steam-engine (*Humphery's*).
See under the respective heads.

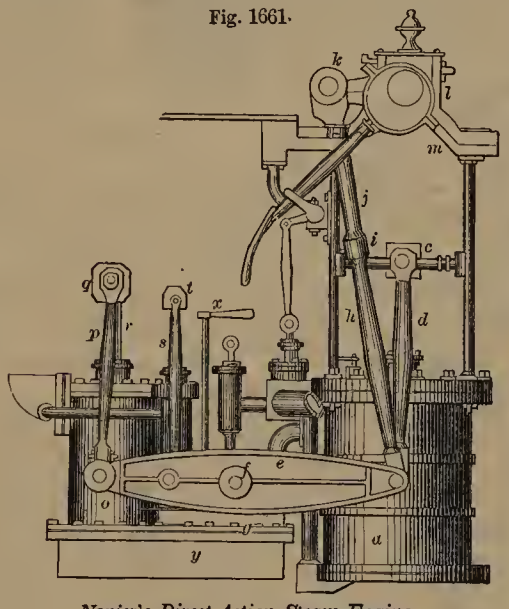
In Napier's direct-action steam-engine, the beam is retained, but only for the purpose of working the pumps.

The cylinders are arranged alongside of each other, and work the cranks on the main shaft, the cranks being set at 90° with each other; but one of the cylinders shows in the side elevation. The cylinders *a* are fixed to a framing, which is bolted to the bottom of the boat. The piston-rods are keyed at the upper ends to cross-heads *c*, to the exterior ends of which are attached the connecting-rods *d*. The lower ends of the latter are inserted in the fork ends of the beams *e*, which vibrate upon a shaft *f*, the bearings of which rest on the top of the condenser *g*. In the same forks are inserted the ends of other connecting-rods *h*, which are keyed at their upper ends to cross-heads *i i*. In the center of these cross-heads are bosses large enough to receive the rods *j j*, which extend to the crank-pins of the cranks *k k*. These cranks are fixed to the main shaft, which rests upon the bearings *l l*, upon the arches *m*, which are bolted to the cross-beam.

The side-beams *e e* are not straight, but have two

bends, the ends near the cylinder being much farther apart than the opposite ends, which are alongside the air-pump, so that they conform somewhat to the shape of the machine, and take up as little room as possible. The beams *e c* are also forked at their ends nearest to the air-pump *o*, in order to admit the insertion of the pump-rods *p*, which are connected at their upper ends with the cross-head *q*, in a bush in the center of which is keyed the air-pump rod *r*. Connecting-rods *s* are

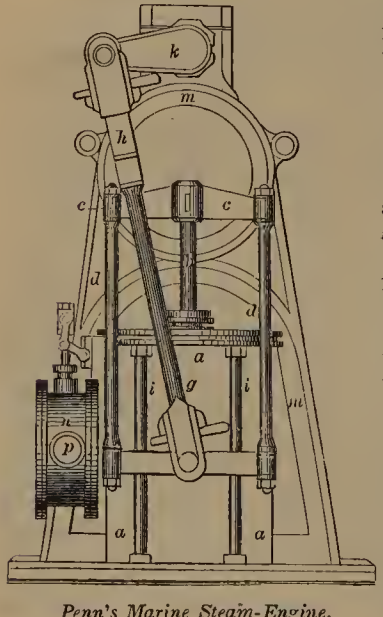
Fig. 1661.



Napier's Direct-Action Steam-Engine.

attached to the side beams *e*, and at their upper ends *t* to cross-heads, which are connected to two rods which work the plungers of two feed-pumps for supplying the boiler. The rod and lever *x* are for the purpose of regulating the quantity of injection water which enters into the condenser, by a pipe from the outside of the vessel, and can be increased and lessened in quantity by turning a cock to which the rod *x* is attached ; *y* is a hot-well, into which the condensing water is discharged from the air-pump. The feed-pumps are supplied with water from this hot-well, through the medium of a pipe, the overplus being discharged through the side of the vessel by another pipe (not shown).

Fig. 1662.



Penn's Marine Steam-Engine.

In Penn's direct-action steam-engine, *a* is the cylinder ; *b* the piston-rod, carrying the cross-head *e c;* this latter consists of four arms, branching diagonally from the center. On each side two side-rods *d d* are suspended from the extremities of the arms *e e* of the cross-head, and are attached at the lower end to a cross-bar, in the center of which is a pin, to which the forked end of the arm *g* of the connecting-rod *h* is coupled ; *i i* are two guide-rods, upon which the bar *e* slides, the rods passing through brass bushes attached to the side of the bar ; *k* is the crank, and *m* the side frame ; *n* the slide-case, and *p* the steam pipe.

Di'rect-draft. In steam-boilers, when the hot air and smoke pass off in a single *direct* flue. In contradistinction to a *reverting*, a *wheel*, or a *split* draft.

Di-rect'or. 1. (*Electricity.*) A metallic instrument on a glass handle, and connected by a chain with the pole of a battery or Leyden jar. It is applied on that part of a body to which a shock is to be sent.

2. (*Surgical.*) A grooved instrument for guiding a bistoury, bullet-extractor, etc.

Dirk. A dagger. The name is Celtic (*diure*), and the weapon forms part of the equipment of a Scotch highlander and an English midshipman.

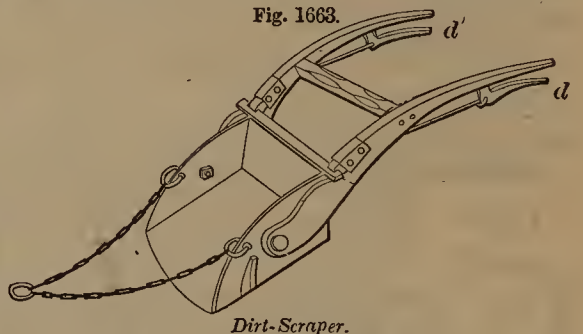
The scalping-knife, stiletto, and bowie-knife are similar implements in favor with other people.

Dirk-knife. A knife with a hinged dirk-blade.

Dirt-board. (*Carriage.*) A board for warding off earth from the axle-arm. A *cuttoo-plate.*

Dirt-scrap'er. A grading-shovel. A road-scraper. An implement drawn by a pair of horses, managed by one man, and used in leveling, banking up,

Fig. 1663.



Dirt-Scraper.

or grading ground. In the example, the shovel turns upon pivots in the frame, and its rear end is engaged by spring catches, which are retracted by levers beneath the handles. Pressure on the triggers *d* allows the shovel to capsize and dump its load.

Dis-charge'. 1. The issuing direction of water from a reaction or turbine wheel : as, the *outward* discharge, or Fourneyron turbine ; the *vertical* discharge, or Jonval turbine ; the *center* discharge, etc.

2. An ajutage.

Dis-charg'er. 1. (*Calico-printing.*) A material with which cloth is printed, in order that the color in which the cloth is subsequently dipped may be removed from those portions printed with the discharger.

The *discharger* acts either upon the coloring matter, or on the mordant before the cloth is exposed to the dye. It acts chemically by converting the coloring-matter into colorless or soluble products ; or upon the mordant by removing its effectiveness in setting the color.

It differs from a *resist* in this, —

A *resist* is an application to prevent a color taking upon a cloth. A *discharger* is to remove it.

2. (*Electricity.*) See DISCHARGING-ROD.

Dis-charge'-style. (*Calico-printing.*) *a.* A mode of calico-printing in which thickened acidulous matter, either pure or mixed with mordants, is imprinted in certain points upon the cloth, which is afterwards padded with a dark-colored mordant, and

then dyed, with the effect of showing bright figures on a darkish ground. Also known as the *rongeant-style.*

b. A mode in which certain portions of color are removed from dyed goods by the topical application of chlorine or chromic acid. See DE-COLORING-STYLE; BANDANNA.

Dis-charge'-valve. In marine engines, a valve covering the top of the air-pump, opening when pressed from beneath.

Dis-charg'ing-arch. (*Architecture.*) One built above a lintel to take the superincumbent pressure therefrom.

Dis-charg'ing-rod. A instrument to discharge a charged electrical jar or battery. It has a glass handle and a pair of hinged rods with balls on the ends, which are brought into connection respectively with the two surfaces or poles of the jar or battery.

Dis'en-gag'ing-gear. (*Machinery.*) Contrivances by which machines are thrown out of connection with their motor, by disconnecting the wheels, chains, or bands which drive them. See CLUTCH; COUPLING.

Dish. 1. (*Vehicle.*) The projection outwardly of the tire beyond the plane of the insertion of the spokes in the hub.

This is not necessary when the spindle of the axle is cylindrical, but when the spindle is tapering, it is necessary to give a *gather* and *swing* to the spindle, and a *dish* to the wheel.

The *gather* is the setting forward of the end of the *spindle* so that the wheel may run freely, not pressing inordinately either on the *nut* or the *butting-ring.*

The *swing* is the setting downward of the end of the spindle so that its lower edge may be horizontal. The load resting thus, the wheel has no special tendency to slip in or out against the *butting-ring* or the *nut.*

The *swing* tips the wheel outward at top, leaning it away from the wagon, and, to enable the bearing on the *spokes*, *fellies*, and *tire* to be vertical, the wheel is *dished;* so that each spoke is vertical as it comes to the lower or working position. The *fellies* being set square on the *spokes*, the *tread* of the wheel is flat on the ground.

2. A flat open vessel in which food is served on table, as distinguished from a *plate* in which it is served to guests.

3. A box having a capacity of 672 cubic inches, in which ore is measured.

Dished. (*Machinery.*) Having a central depression. Hollowed, cup-shaped.

Dished-out. A term applied to the sunk cradling employed in vaults, coved ceilings, and domes which are formed by wooden ribs (*bracketing*) upon which the lath and plastering are secured.

Dish-heat'er. A warming-closet attached to a stove or exposed in front of a fire to heat dishes.

Dish-hold'er. A grasping-implement for hot dishes, or for holding them while washing in very hot water.

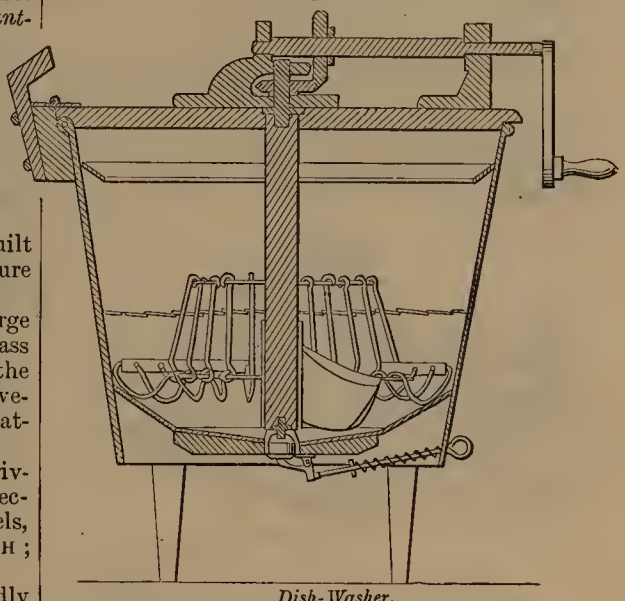
Dish'ing. (*Of wheels.*) See DISH.

Dish-rack. A frame in which dishes and plates are placed to drain and dry.

Dish-wash'er. A device by which dishes are cleaned by agitation, in some cases assisted by brushes or sponges. Among the numerous varieties may be cited the circular rack rotated in a tub with water sufficient to submerge the dishes and plates.

Dis'in-fect'or. An apparatus for disseminating a gas, vapor, or fine spray for the purification of the air and the counteraction of contagious influences.

Fig. 1664.



Dish-Washer.

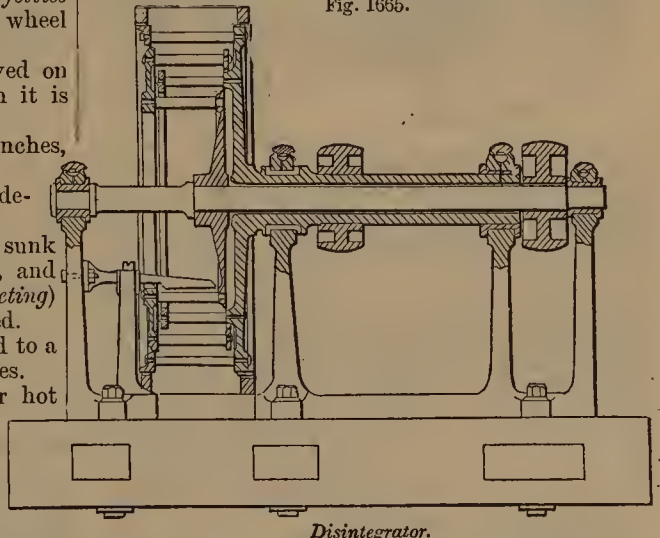
The modes are various: Atomizers for spraying; vessels in which gases are eliminated by chemical action; vapors generated by the heat of lamps beneath vessels containing the ingredients; blowers by which a medicated atmosphere is diffused; trays in which the materials are exposed to the ordinary currents of air; pastiles for burning; odors and perfumes for disguising; earth and charcoal for absorbing.

Among disinfectants may be cited chlorine, chloride of lime, carbolate of lime, carbolic acid, chloride of zinc, chloride of iron, permanganate of potash, sulphurous acid fumes, roasting coffee.

Dis-in'te-grat'or. 1. A machine for grinding or pulverizing bones, guano, etc., for manure.

2. A mill in which grain is broken into a fine dust by beaters projecting from the faces of parallel metallic disks revolving in contrary directions, as

Fig. 1665.



Disintegrator.

in the figure. The grain is fed in at the center, and in falling is caught by the horizontal bars which project from the rapidly rotating disks. The grain acquires a vortical motion which by centrifugal impulse is caused to run the gantlet of the beaters, which are in concentric series and run in alternate directions and at high velocity. See FLOUR-MILL.

Disk. One of the collars separating and fastening the cutters on a horizontal mandrel.

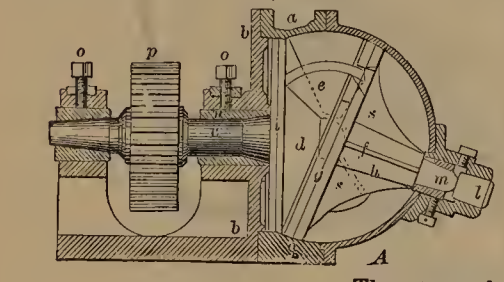
A flat circular plate.

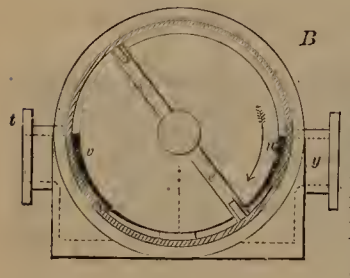
Disk Steam-en'gine. A form of *rotary steam-engine* which was invented by Ericsson and improved by Bishopp and others.

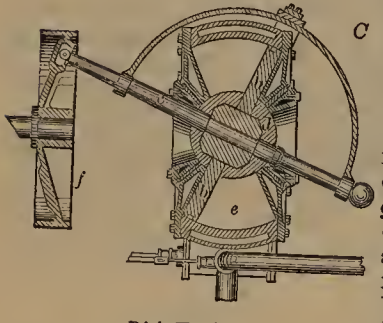
In the *Ericsson engine* the disk *revolves*, and in the *Bishopp engine* the disk *wobbles*.

Ericsson's disk steam-engine (*A B*, Fig. 1666).

Fig. 1666.







Disk-Engines.

The steam-chamber *a* is the segment of a sphere, and is fastened by flanges to the head *b*. *c* is the engine-shaft, having a gear-wheel *p*. On the end of the shaft is a flat cone *d*, having packing *i* around its circumference and a spherical knob at its end, which works in a corresponding cup or socket in the center of the disk *g*, which has a packing around its periphery. The disk *g* has strengthening ribs *s* and an axis running in a conical bearing *m*, which is adjusted by a set screw. A brass bearing *l* against the end of the axis forces the disk against the cone *d*, the lower side of the disk remaining in constant contact with the lower side of the cone throughout the revolution ; the two contacting objects revolve in different planes by the action of the steam on the sectors *e e*. These sectors are attached to the cone and form the piston, and the point of contact of the disk and cone forms the abutment. The sectors pass through slits in the disk, sliding back and forth ; occupying the whole width of the steam space at the upper portion of their stroke, and then receding as the surfaces of the disk and cone come in contact at the lower point, on the respective sides of which are the induction and eduction steam-ports.

The steam passes through the neck *t* into the spherical chamber through an opening *v* cut through its side ; this opening is of triangular shape, and made as wide at top as the circular plane is there distant from the base of the cone, and gradually tapering off downward ; *w* is the opening through which the steam escapes into the atmosphere, or into the condenser, as the case may be, through the neck *y*. The dotted line *x* shows where the cone and circular plane come in contact.

Steam admitted into the spherical chamber by the neck *t* and opening *v*, and being there prevented from passing the line *x* by the pressure of the disk against the cone at that place, it presses against the upper leaf *e*, which, together with the cone and disk, is thereby carried round in the direction of the arrow. When the leaf has passed the upper part of the opening *w*, the steam that has been acting upon it escapes, but at the same time the opposite leaf has passed the top of the steam-opening *v*, and is carried round in a similar manner.

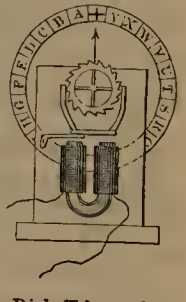
The engine has no valves, the action of the piston is at all times direct, and the engine can be stopped, started, or reversed at any position of the piston.

Bishopp's disk steam-engine (English), (*C*, Fig. 1666). The piston of this engine has the form of a disk *b* attached to a shaft *c*, which has a sphere *d* on its mid-length occupying a space between two frustums of cones which form the cylinder-heads. The center of the sphere occupies the position that would form the point of meeting to the apexes of the two cones, were they prolonged. The disk and shaft do not revolve on their axis, though the ends of the shaft describe circles, as the disk *wobbles* on the cones, keeping one radius on each side in constant contact with them respectively. An abutment is formed by a plate *e*, which divides the annular space in which the steam works, the lower portion of the disk having a radial slit which enables it to slip back and forth on the abutment-plate *e*. The steam is admitted on one side of the abutment and exhausted on the other, the live steam pushing the disk before it by crowding between it and the conical head, and causing the outer end of the arm to communicate a rotary motion to a wheel *f*, to which it is connected by a universal joint.

Disk-tel'e-graph. One in which the letters and figures are arranged around a circular plate and are brought consecutively to an opening, or otherwise specifically indicated.

The first of this class of telegraphic apparatus seems to have been that of Ronald, England, 1816. At each end of the line he had clocks beating in exact unison ; at least, such was the requirement of the invention. Each clock-work rotated a disk having the letters and numerals on a circular track, and these were exposed in consecutive order at an opening in the dial, the two ends of the line showing the same letter coincidently. The sender of a message watched till the required letter came in view, then made an electric connection which diverged a pair of pith balls and drew attention to the letter. This was repeated for each letter, the parties waiting till the required letter came in its turn to the openings in the respective dials. It was a slow business, and came to naught.

Fig. 1667.



Disk-Telegraph.

Fig. 1667 shows a form of this instrument in which the armature of the magnet has two spring pieces, which act upon the ratchet-wheel as the armature vibrates to and fro, when the connection is made and broken. The pieces are respectively a *clawker* and *driver*, that is, a pulling-hook and a pushing-arm, so that each motion of the armature is made effective in moving the ratchet, and also the lettered disk.

Disk-valve. A valve formed by a perforated disk which has a rotation, partial and reciprocating,

Fig. 1668.

Disk-Wheel.

or complete, upon a circular seat whose apertures form ports for steam or other fluid.

Disk-wheel. This differs from the usual worm-wheel in the mode of presenting the spiral to the cog-wheel. In the illustration the spiral thread on the face of the disk drives the spur-gear, moving it the distance of one tooth at each revolution. The shafts are at right angles to each other.

Dis-part'. (*Gunnery.*) The difference between the muzzle and breech thicknesses of a piece of ordnance. A piece of metal is cast on the muzzle to bring the line of sight parallel to the axis of the piece, and is known as the *dispart-sight* or *muzzle-sight.*

Dis-part'-sight. A gun-sight, to allow for the dispart, and bring the line of sight and the axis of the piece into parallelism.

Dis-patch'-boat. A name given to a swift vessel, formerly a fast sailer, now a small steamboat, used in dispatch duty.

Dis-patch'-tube. A tube in which letters or parcels are transported by a current of air induced by a plenum or vacuum. See PNEUMATIC TUBULAR DISPATCH ; ATMOSPHERIC RAILWAY.

Dis-place'ment. (*Of a vessel.*) The weight of water displaced, which is equal to her own weight and that of her lading.

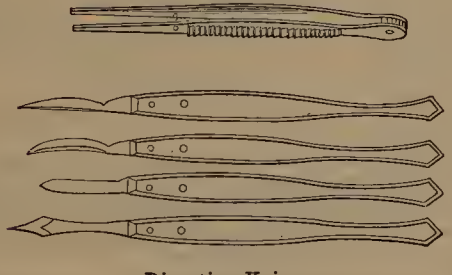
Dis-played'. (*Printing.*) Said of matter when lines are put in type more prominent than the body letter.

Dis-sect'ed Map. An educational device to teach geography. A map is pasted on to a thin board or veneer, and thus mounted is sawed apart into pieces, following the national lines of demarcation. The pieces being mixed, ingenuity and study are required to fit them all together in order.

Dis-sect'ing-for'ceps. A pair of long tweezers used in dissecting.

Dis-sect'ing-knife. The knives of the Egyptian embalmers were of an Ethiopic stone, probably flint. Herodotus describes them. A flint knife was

Fig 1669.



Dissecting-Knives.

also used by the Hebrews, Egyptians, and Ethiopians in performing the operation of circumcision. See KNIFE.

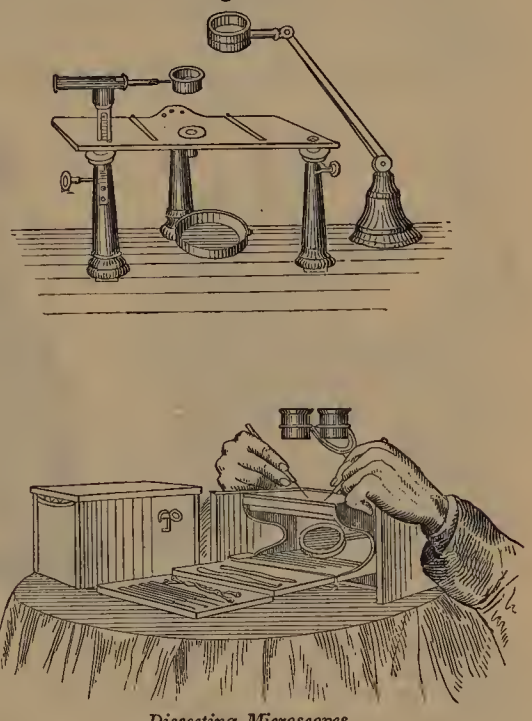
"Then Zipporah took a sharp stone and cut off the foreskin of her son, and cast it at his [Moses] feet." — *Exodus* iv. 25.

The dissection of the human body for purposes of science was ordered by Ptolemy Philadelphus in the college of Alexandria. He even authorized the vivisection of criminals condemned to death. Herophilus of Cos was among the first of the professors in this great school of medicine. The practice of dissection was very repugnant to the prejudices of the Egyptians, where to touch a corpse was defilement, as we see it also to have been among the Hebrews, who became habituated to many of the Egyptian modes of thought.

Vesalius, born at Brussels 1514, died 1564, was among the most noted of the school of modern anatomists who have pursued the study of dissection. His distinguished professional career was terminated by an unfortunate affair, which turned out to be a vivisection, as the supposed cadaver proved to be living. The relatives who had granted the dissection denounced Vesalius to the Inquisition, who would have burned him but that Philip II. stepped in and had the sentence commuted to a pilgrimage to Jerusalem. Decidedly preferable.

Dis-sect'ing-mi'cro-scope. The stage of the upper figure has rack-adjustment for focus, spring clips to hold object-slide, diaphragm, movable arm for carrying the lenses, separate jointed stand

Fig. 1670.



Dissecting-Microscopes.

on which any of the sets of lenses can be placed and used for rough or preliminary examinations ; mirror on joint, three sets of doublets, of low, medium, and high power.

The lower figure is of a binocular microscope of moderate power, for anatomical and botanical investigations. It is made to close up in a box the top and front of which contain loops to hold the knives, scissors, tweezers, needles, etc. Beneath the eye-glass is a gutta-percha stage and a circle of glass illuminated by a mirror below.

Dis-solv'ing-views. Produced by the magic-lantern or the stereopticon.

Two magic-lanterns are placed side by side, their lens-tubes slightly convergent, so that each will deliver its picture upon the same portion of the screen. A tapering plate slides in front of both tubes, and is so arranged that it may shut off the aperture of either or allow a portion of the image from each to pass to the screen.

One being closed, the other is fully displayed.

Now, by moving the shutter, the image from the exhibited picture is gradually dimmed and that of the other as gradually develops. When the shutter is midway, the pictures are equally prominent and are therefore confused. The shutter continuing to move, the new picture commences to predominate, and eventually occupies the screen entirely, the other image being excluded. A change of pictures now being made in the darkened lantern, it is ready for the return motion of the shutter, which makes a similar change to that just described. The name is well given, as the pictures gradually dissolve into each other, there being no sudden removal, change, or substitution.

Dis'taff. A cleft stick about 3 feet long, on which wool or carded cotton was wound in the ancient mode of spinning. The distaff was held under the left arm, and the fibers of cotton drawn from it were twisted spirally by the forefinger and thumb of the right hand. The thread as it was spun was wound on a reel which was suspended from and revolved with the thread during spinning.

"A virtuous woman layeth her hands to the spindle, and her hands hold the distaff." — SOLOMON.

The figures in group *a*, annexed, show a party of

Fig. 1671.

Distaff, — Ladies at Work.

ladies of the Middle Ages, engaged in the duties of ladies of rank at that time. "The mistress, as with the lady in Proverbs, layeth her hands to the spindle, and her hands hold the distaff." She is represented as cutting up a piece of cloth to make into garments, while two of her maidens are at work with their distaffs.

The figure *b* is the more modern Italian.

The distaff and spindle are referred to repeatedly in the Old Testament, and were the only known means of spinning in Egypt, Phœnicia, Arabia, India, Greece, and Rome. Distaff spinning and weaving are shown at Beni Hassan, in Egypt. The Greeks represented Minerva with a distaff as being the inventress of spinning.

Catullus describes it clearly: —

> "The loaded distaff in the left hand placed,
> With spongy coils of snow-white wool was graced;
> From these the right hand lengthening fibers drew,
> Which into thread 'neath nimble fingers grew.
> At intervals a gentle touch was given,
> By which the twirling whorl was onward driven.
> Then, when the sinking spindle reached the ground,
> The recent thread around its spire was wound;
> Until the clasp within its nipping cleft
> Held fast the newly finished length of weft."

Dis-tem'per. A kind of painting in which whiting is used as the basis of the colors, the liquid medium being size; it is much used for ceilings and walls. See DESTEMPER.

Dis'til-la'tion. The volatilization of a liquid and condensation in a separate vessel.

Zosimus, the Panopolitan, described the operation for the purification of water, and the Arabs called the instrument an alembic. Djafar, eighth century, obtained nitric acid and aqua regia, and Rhazes absolute alcohol and sulphuric acid. See ALEMBIC; STILL.

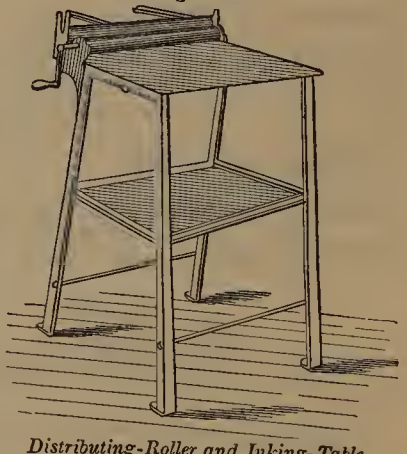
Dis-trib'ut-ing. (*Printing.*) The operation of returning from the column to the *case* the letters, etc., which made up the *matter*.

The compositor wets a page or part of a column of matter, and takes up a number of lines on his distributing-rule. The wetting causes the types to adhere slightly together. He takes a few words between his finger and thumb, and, reading the purport, by a dexterous slackening of his grip, so as to loosen the type *seriatim*, he throws the several letters into their various boxes. *Distribution* is said to be four times faster than composition. See TYPE-DISTRIBUTING MACHINE.

Dis-trib'ut-ing-res'er-voir. A small reservoir for a given district, capable of containing a volume of water equal to the whole excess of the demand for water during those hours of the day when such demand exceeds the average rate, above a supply during the same time at the average rate. The greatest hourly demand for water is about double the average hourly demand. The least that a distributing-reservoir should hold is half the daily demand.

Dis-trib'ut-ing-roll'er. (*Printing.*) A roller on the edge of an inking-table for distributing ink to the printing-roller. At the side of the table is an ink-trough which is pressed up against the *distributing-roller* by balance-weights. The distributing-roller presents a line of ink to the printing-roller, which is then run back and forth on the table to spread the supply of ink evenly around it.

Fig. 1672.



Distributing-Roller and Inking-Table.

The arrangement was invented by Professor Cowper, and is described in his English patent of 1818.

The distributing-roller in printing-machines carries ink from the *ductor-roller* to the inking-roller. To secure an even distribution, it is found necessary to give an endwise motion to the roller.

This is secured in one of two ways.

Professor Cowper's plan was to give a longitudinal motion to the axis (English patent, 1818).

Applegarth's method was to place the axis of the distributing-roller obliquely to the surface against which it moved. It thus had a *relative* endwise mo-

tion, which distributed the ink along as well as around the rollers involved in the combination.

Dis-trib'ut-ing-rule. (*Printing.*) A rule used in separating the lines of type in distribution.

Dis-trib'ut-ing-ta'ble. (*Printing.*) The slab on which the ink is spread and transferred to the rollers.

Dis'tri-bu'tion. The application of steam in the engine in respect to its induction, eduction, expansive working, etc.

Ditch. 1. (*Fortification.*) A trench or *fosse* on the outside of a fortification or earthwork, serving as an obstacle to the assailant and furnishing earth (*déblai*) for the parapet (*remblai*). It is from 90 to 150 feet broad, in regular fortifications, much narrower in mere earthworks or entrenched positions. The side of the ditch nearest the place is the *scarp* or *escarp*, and the opposite side, the *counterscarp*, is usually made circular opposite to the salient angles of the works. See BASTION.

Under the ancient system of fortification, the ditch was frequently dug on the inside, thus anticipating by some thousands of years the improvement of Pillow, during the Mexican war, —

> "He who dug for Polk and Marcy
> Ditch and rampart vi-ce var-sy."

The object of the savages is evident. It was to obtain shelter for the bodies of the archers with the least amount of labor; and by this system they most readily obtained the required shelter, having the benefit of the ditch and the bank. The Mandan Indians adopted this plan. The system is seen in the modern rifle-pit.

The *fossa* around a Roman encampment was usually 9 feet broad and 7 feet deep; but if an attack was apprehended, it was made 13 feet wide and 12 feet deep. The *agger*, or parapet, of the encampment was raised from the earth of the *fossa*, and was crowned with a row of sharp stakes. *Valli.*

The ditch outside the rampart on the western side of Rome was 100 feet wide, 30 deep. The work was constructed by Servius Tullius.

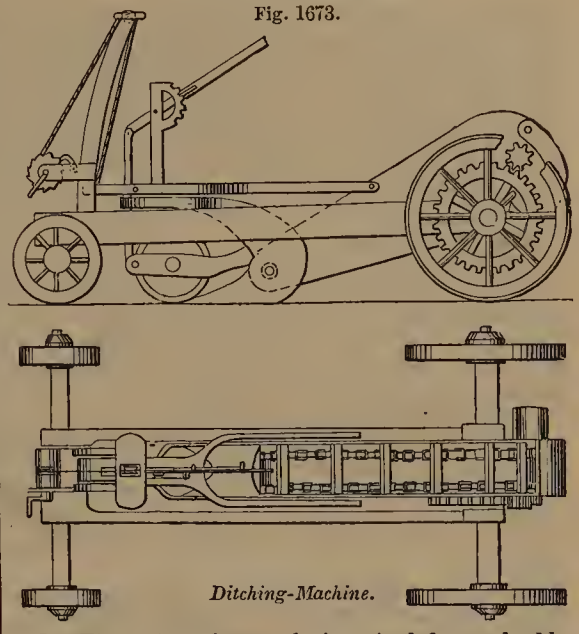
2. An artificial water-course for drainage.

By the laws of Solon (594 B. C.), no one was allowed to dig a ditch but at the same distance from his neighbor's land that the ditch was deep. This was the same in the Roman laws of the twelve tables. The Grecian law compelled one who planted common trees to place them no nearer than 9 feet from his boundary; olives, 10 feet. The law of the twelve tables made it, olives and figs 9 feet, other trees 5 feet.

The agricultural ditches of the Romans were open (*fossa patentes*) or closed (*fossa cæcæ*); the latter usually 3 feet broad at top, 18 inches at bottom. The lower portion was filled with stone or gravel, a layer of pine leaves or willows, and then the earth replaced. Sometimes a large rope of withes or a bundle of poles was placed in the bottom.

Ditch'ing-ma-chine'. One adapted to excavate a deep trench and deposit the earth at the side of the same. In this sense a plow may be a ditching-machine, and in fact is often so used in running shallow ditches for surface-draining, but it will only make it single-furrow depth. There are many modifications of the plow for attaining extra depth.

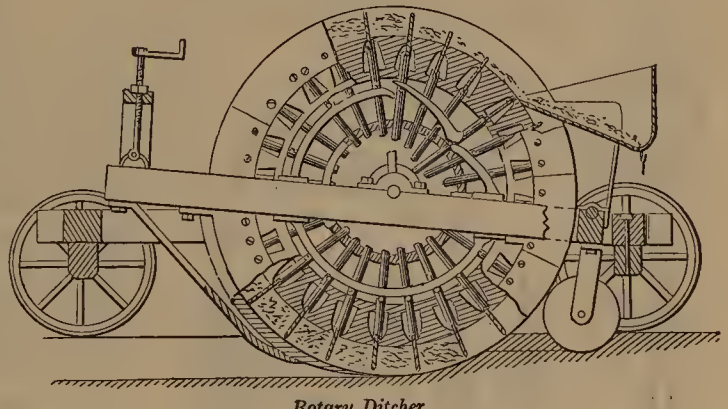
Fig. 1673.



Ditching-Machine.

In Fig. 1673, the earth is raised by a double-pointed, concave-topped plow, and the earth is compacted upon it by an adjustable roller. The earth is carried upward and backward by an endless conveyer.

Fig 1674.

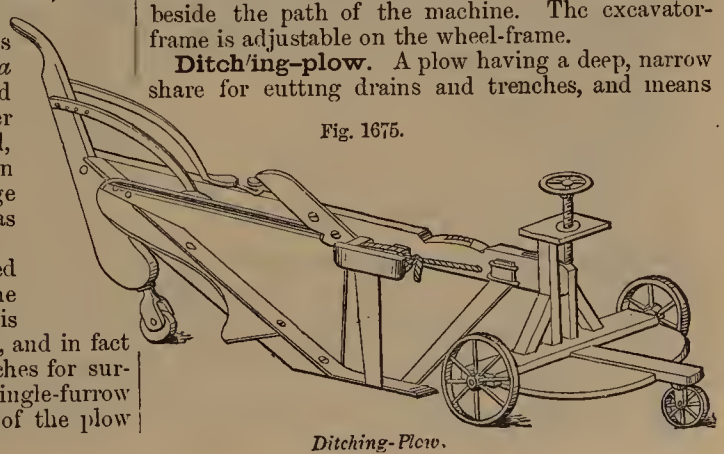


Rotary Ditcher.

Of a different type is the rotary ditching-machine, in which the earth is taken up in circumferential recess between the sectional rim-plates of the wheel, being bound therein by the radial spades which are projected to engage and retracted to free the earth by fixed cams upon the frame. The inclined scraper removes the earth from the recess, and deposits it beside the path of the machine. The excavator-frame is adjustable on the wheel-frame.

Ditch'ing-plow. A plow having a deep, narrow share for cutting drains and trenches, and means

Fig. 1675.



Ditching-Plow.

for lifting the earth and depositing it at the side or sides of the excavation. In Fig. 1675, the forward carriage straddles the ditch, and the rear supporting-wheel runs in the ditch behind the cutting and elevating mechanism. The share is supported by colters, which cut the sides of the ditch, and deliver the furrow-slice to the guides upon which it rises, and to the mold-boards which deliver it on the side of the ditch. Adjustments for varying depths are recited in the claims.

Ditch'ing-tools. Spades of various shapes for different forms and depths of ditches. Scoop-shaped for clearing out the bottoms; paring-spades for removing the turf. Level and reel-line for laying out the work. Plows, ditching-machines, and excavators for reducing the amount of hand-work.

Di-ver'sion-cut. A channel to divert past a reservoir a stream of impure or turbid water which would otherwise flow into the reservoir. A *by-wash.*

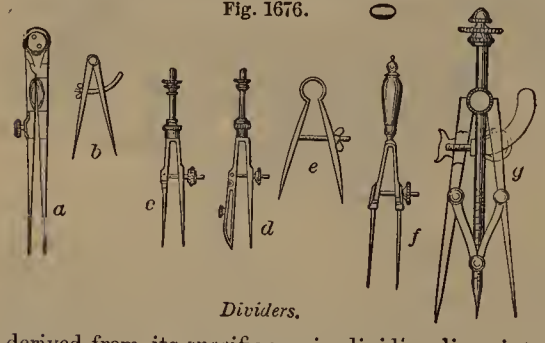
Di-vid'ed Ax'le. One bisected at its mid-length. In some instances the parts are coupled together, in others they are independent. See CAR-AXLE.

Di-vid'ed Ob'ject-glass Mi-crom'e-ter. Another name for the *double-image* micrometer. The object-glass of the telescope or microscope is bisected diametrically, the straight edges being ground smooth so that they may easily slide by each other. The halves of the bisected lens are movable in a direction perpendicular to the line of section by means of a screw; the distances being determined by the number of revolutions necessary to bring the points to be measured into optical coincidence.

Di-vid'er. (*Husbandry.*) The prow or wedge-formed piece on a reaping-machine, which divides the grain to be cut from the standing grain.

Di-vid'ers. A form of compasses, usually with an adjusting and retaining arrangement. Its name

Fig. 1676.



Dividers.

is derived from its specific use in dividing lines into any given number of equal parts. The legs are driven apart by a spring as the nut is retracted on the screw, and closed by contrary motion of the said nut; the fine thread of the screw admitting of a very delicate adjustment.

a, dividing compass.
b, dividers with arc.
c, steel spacing-dividers.
d, steel spacing-dividers with pen-leg.
e, bow-dividers.
f, spring-bow dividers, with handle.
g, bisecting-dividers.

Di-vid'ing-en'gine. A machine for dividing a circle into a number of parts of equal proportions, either for the purpose of graduation, as the circles and arcs of astronomical, surveying, and plotting instruments, or for spacing off and cutting the circumference of a wheel into teeth.

The first notice we find is in connection with a mode of originating screws by Pappus Alexandrinus, a Greek mathematician of the fourth century. His process was by a thin templet of brass of the form of a right-angled triangle, the angles of which were made in accordance with the pitch of the proposed screw. The perpendicular being wrapped around the rod at right angles to the axis, the hypoteneuse gave the spiral of the screw, and the base the pitch.

The subject of originating screws, which is closely connected with the dividing-engine, may be pursued in Holtzapffel (Vol. II. pp. 635–655).

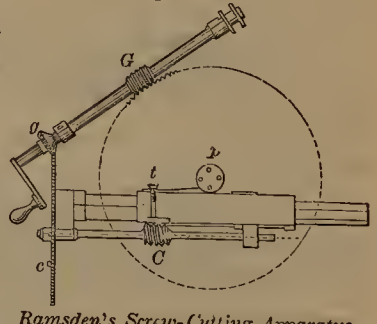
The methods of graduating instruments received much attention from Tompion (1660), Sharp (1689), the Sissons, and Bird (1745), the latter receiving £500 from the Board of Longitude for his method of dividing. Hindley, in 1740, constructed an engine for dividing circles, which also served to cut clock-wheels.

Ramsden, in 1766, contrived his dividing-engine, and in 1777 received a reward of £615 from the Board of Longitude. Following Ramsden were the Troughtons, father and son, the latter of whom received the Copley medal of the Royal Society of England for his improved method of graduation.

Ramsden's circular dividing-engine consisted of a large wheel moved by a tangent screw. The wheel was 45 inches in diameter, and had 2,160 teeth, so that six turns of the tangent-screw moved the circle one degree. The screw had a micrometer and also a ratchet-wheel of sixty teeth, therefore one tooth equaled one sixth of a minute of a degree. The diamond point always moved on one fixed radial line, by means of a swing-frame. The circumference of the 45-inch circle was originally divided into five parts, each of these into three; these were then bisected four times, dividing the wheel into 240 parts, each of which was designed to contain nine teeth.

The first application of the tangent-screw and ratchet to the purpose of graduation is stated by Holtzapffel to have been by Pierre Fardoil. See plate 23 of Thiout's "Traité d'Horlogerie," etc., Paris, 1741.

Fig. 1677.



Ramsden's Screw-Cutting Apparatus.

Fig. 1677 illustrates Ramsden's application of the principle of the engine just described in originating the screw of his dividing-engine for straight lines. The guide-screw *G* is turned by the winch, and in each revolution moves the larger tangent-wheel one tooth, winding on to the boss *p* a slip of watch-spring which carried the slide on which the tool *t* was fixed, thus cutting the screw *C*, which was at the same time rotated by the gearing *c g* from the prime shaft. The object was to cut a certain number of threads to the inch, and this was obtained by a tentative process by gradually reducing the diameter of *p* until 600 turns of the handle gave a motion of 5 inches to the tool-slide.

In the application of the screw to the graduation of mathematical scales, it is employed to move a platform which slides freely and carries the scale to be graduated, the swing-frame for the diamond-point being attached to some fixed part of the framing of the machine.

Donkin followed up the matter in 1823 in devising correctional methods for Maudslay's devices,

to which we cannot devote room. See Holtzapffel, pp. 651–655.

In 1843, Mr. Sims applied self-acting apparatus to Troughton's circular dividing-engine, and an instrument of their manufacture may be seen at the Coast Survey building, Capitol Hill, Washington. It has been somewhat modified by Mr. Würdemann, of Washington, and is now driven by a small turbine in the stand. See GRADUATING-MACHINE.

Di-vid'ing-sink'er. (*Knitting-machine.*) One of the pieces interposed between *jack-sinkers*, which, being advanced while the latter are retracted, force the yarn between the needles of each pair, so that by the joint action of the *jack-sinkers* and the *dividing-sinkers* the yarn is looped on each of the needles.

Div'ing-bell. An apparatus, having some analogy in shape to a bell, in which persons may descend and remain for a while in safety beneath the surface of the water.

The analogue, in the natural world, of the diving-bell, is found in the contrivance of the diving-spider, whose submerged habitation has been described by De Geer. These spiders spin in the water a cell of strong, closely woven white silk, in the form of a diving-bell or half a pigeon's egg. This is sometimes quite submerged, at others partly above the water, and is always attached to some objects near it by a number of irregular threads. It is closed all round, but has a large opening below, which is closed when the insect is hibernating.

The diving-bell is said to have been used in Phœnicia 320 B. C. This was about twelve years after the capture of insular Tyre by Alexander, and perhaps was used in the recovery of valuables thrown into the sea to prevent capture by "young Ammon."

Aristotle (350 B. C.) speaks of a kind of kettle by which divers could supply themselves with fresh air under water. It is related by Jerome that Alexander the Great entered into a vessel, called a *colymphα*, having a glass window to it, and in which he descended to the bottom of the ocean.

The application of the diving-bell in Europe is noticed by John Tasnier, who attended Charles V. in a voyage to Africa. He relates that he saw "at Toledo, in Spain, in the year 1538, in the presence of the emperor and several thousand spectators, two Greeks let themselves down under water in a large, inverted kettle, with a light burning, and rise up again without being wet.

After this period, the use of the diving-bell became generally known, and is noticed in the "Novum Organum" of Sir Francis Baron, published 1620; in which the device is referred to as being in use in his time. It is described as a machine used to assist persons laboring under water upon wrecks, by affording a reservoir of air to which they may resort whenever they require to take breath. "A hollow metallic vessel was let down evenly to the surface of the water and carried down the air it contained. It stood upon three feet like a tripod, which were in length somewhat less than the hight of a man, so that the diver, when he was no longer able to contain his breath, could put his head into the vessel, and, having breathed, return again to his work."

The next use of the bell was in 1642, in America, when Bedall of Boston used submerged weighted "tubs," in which he descended to the "Mary Rose," which had sunk the previous year. The lifting-arrangements were completed by means of the diving-bell, and the loaded vessel transported to shoal water and recovered.

In the year 1687, the sum of £300,000 was recovered by a diving-bell, at a depth of 7 fathoms, from a Spanish ship which had been wrecked near the Bermudas. The bell was the invention of William Phipps, an American of Pemaquid, in that part of the Colony now known as the State of Maine. Phipps was brought up as a ship-carpenter in Boston, and made many unsuccessful attempts to interest parties in the work. When he succeeded, James II. was urged to confiscate the £16,000 which came to the share of William Phipps; for once in his life the king refused to do a mean thing. Phipps was afterwards made high-sheriff of the Colony, was knighted, and subsequently was governor.

The English patent of John Williams, 1692, is for an "engine for carrying four men 15 fathoms or more under water in the sea, whereby they may work twelve hours together without any danger." It is stated to be useful in raising sunken vessels. It had a submerged chamber, communicating with the surface by a rigid tube, up and down which persons might pass. Projecting sleeves and hooks afforded means for directing grapnels to sunken property.

Beckmann mentions a print in Vegetius on War, published in 1511 and 1532, representing a diver with his cap, from which rises a long leather pipe provided with an opening above the surface of the water. Lorini on Fortification, 1607, shows a square box, bound with iron, furnished with windows and a seat for the diver. Kessler in 1617, Witsen in 1671, and Borelli in 1679, gave attention to the subject and contributed to the efficiency of the apparatus.

A diving-bell company was formed in England in 1688, and the operators made some successful descents on the coast of Hispaniola. In 1664, cannon were recovered from wrecks of the Spanish Armada by the Laird of Melgim, near the Isle of Man, but not sufficient to pay. Previous unsuccessful attempts had been made by Colquhoun, of Glasgow, who depended for air upon a leathern tube reaching above the surface of the water. Dr. Halley, in 1715, improved the diving-bell by a contrivance for supplying it with fresh air by means of barrels lowered from the vessel, from which the bell was suspended, the foul air escaping by a cock. This also allowed the bell to be completely filled with air, rendering the whole of its interior space available. Halley also invented a waterproof cap to which pipes leading to the bell were attached, so that an operator could leave the bell and walk on the bottom outside, being supplied with air by the pipe. This resembled in some respects the modern submarine armor, helmet, and diving-dress, which had been in occasional use since early in the sixteenth century (*ut supra*). Spalding, in 1774, made farther improvements by suspending a balance-weight from the bell that on striking bottom took off the weight of the bell, which with its included air, being too light to sink, was more readily raised or lowered by the admission of air or water into an upper compartment, placing it completely under the control of those within it. For this the British Government decreed him a reward. The celebrated engineer Smeaton, about the year 1779, first used it for engineering purposes, and in 1788, having to prepare the foundation for the pier in Ramsgate Harbor, he contrived a bell by which the work was very greatly facilitated. This consisted of a nearly conical box of cast-iron, of great weight and solidity, capable of containing 50 cubic feet of air, or sufficient for two persons one hour; this was constantly charged by means of a pipe leading to a force-pump above. The diving-bell has been subsequently applied with great success to many important submarine engineering operations, and for the purpose of recovering valu-

ables from shipwrecked vessels, etc., but of late years seems to be nearly superseded by the recent improvements in submarine armor. The principle of the diving-bell may be illustrated by taking a tumbler, inverting it, and pressing it down into a vessel of water, when it will be seen that, although the water will rise in the tumbler to an extent proportioned to its degree of immersion, yet the upper part of the tumbler will remain perfectly dry, and if a lighted taper be placed within, it will not be extinguished, but will, on the contrary, burn with even increased energy, owing to the condensation of the air by pressure. Mr. Brunel found that at the depth of 30 feet he could hold his breath two minutes, or double the usual time, the amount of air taken into the lungs at one inspiration being in fact double what it would have been at the surface.

Dr. Faraday relates the curious fact, that the lungs are, in their natural state, charged with a large quantity of impure air; this being a portion of the carbonic-acid gas which is formed during respiration, but which, after such expiration, remains lodged in the involved passages of the pulmonary vessels. By breathing hard for a short time, as a person does after violent exercise, this impure air is expelled, and its place is supplied by pure atmospheric air, by which a person will be enabled to hold his breath much longer than without such precaution. Dr. Faraday states that, although he could only hold his breath, after breathing in the ordinary way, for about three quarters of a minute, and that with great difficulty, he felt no inconvenience, after making eight or ten forced respirations to clear the lungs, until the mouth and nostrils had been closed more than a minute and a half; and that he continued to hold breath to the end of the second minute. A knowledge of this fact may enable a diver to remain under water at least twice as long as he otherwise could do.

The experience of a French diver, who descended for the purpose of examining the wreck of a steamer sunk off Ushant in 1865, is interesting. He found that at the depth of 195 feet the general pressure over the whole body was so great that the bladder was involuntarily emptied. At this depth he rested on the sands in which his feet sank. He detaches one end of the guide-cord; he can distinguish this cord, the weights, and his hands, and he advances a few steps. He has great difficulty in withdrawing his feet from the sands, to which he feels rooted. All at once his sight is obscured, his head turns; he returns instinctively to the ladder, and asks to be raised. He begins to ascend as well as his strength will allow, feels himself impeded by his guide-cord, which he cuts, and then rises alone very rapidly, having lost his senses. A violent shock brings him to; he recognizes the side of the ship from which he had descended, against which his mask has struck, and regains his courage. He waves his hand above the surface of the water, and feels himself sinking. His mask having got displaced, the collar almost chokes him. He feels himself grasped by the arms, and grasps a rope which his hand happened to touch. He again loses consciousness for a moment in the ship's boat, and asks to be raised on deck as soon as his mask shall be unscrewed. He suffers much from his right hand, and breathes with difficulty; his extremities are cold and neck painful. Twice he nearly faints and ceases to breathe. His sight appears troubled, everything turns round with him, and his gaze has no steadiness. This, as the idiom shows, is the French account, and is preferably given without impairing its graphic character. The conclusion arrived at on this occasion was, that it was impracticable to work for any length of time at a depth exceeding 130 feet.

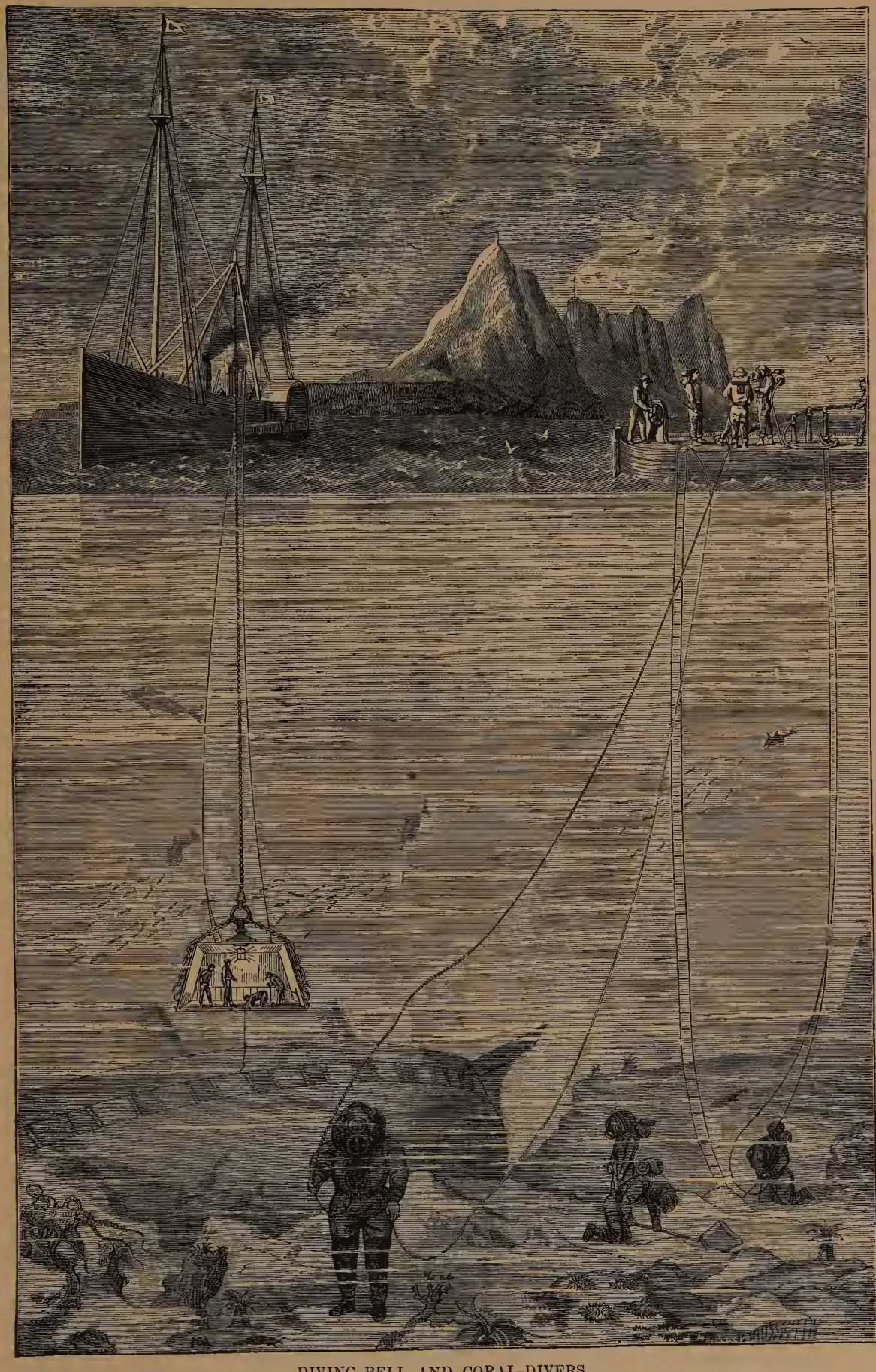
In 1869, however, the ship "Hamilla Mitchell" was lost on the Leuconia rocks, near Shanghai; and two English divers, provided with the apparatus of Siebe and Gorman, were subsequently sent from Liverpool to attempt the rescue of the treasure on board. One of these succeeded in remaining four consecutive hours under water at the depth of 23 fathoms upon one occasion, during which he recovered 64 boxes of specie.

The engraving on the opposite page illustrates submarine operations at the anchorage off Gibraltar, as conducted with the diving-bell in conjunction with divers arrayed in the apparatus of Ronquayral and Denayrouze. In this, whether the man be naked or covered with impervious clothing, his respiration may be made to depend on the exercise of his own will and the power of his lungs, or the air-supply reservoir may be supplied by air-pumps above, as shown in the figure. The artificial lung or air-supply regulator consists of a strong metallic reservoir, preferably steel, capable of resisting great pressure, and surmounted by a chamber so constructed as to regulate the efflux of air. This is carried on the diver's back. A respiratory tube issues from the chamber, and is terminated by a mouthpiece of sheet caoutchouc, which is held between the lips and teeth of the diver. This pipe is furnished with a valve, which permits the expulsion of air, but opposes the entrance of water. The steel reservoir is separated from the air-chamber by a conical valve opening from the air-chamber toward the reservoir, so as to open only under the influence of an exterior pressure, the tendency of the pressure of the air in the reservoir being to keep it closed.

This apparatus dispenses with the necessity for keeping the air-pump in continual operation. The air which the diver inhales is stored up in the steel reservoir, and from this he supplies himself without fatigue in the following manner. The air-chamber is closed by a movable lid, to which is attached the stem of the valve before referred to. The diameter of the lid is somewhat less than the interior diameter of the chamber, and it is covered with caoutchouc, to render it air-tight. It yields to both interior and exterior pressure, the former causing it to rise and the latter to fall. When exterior pressure is exerted on this lid, the valve is opened, establishing a communication between the reservoir and the air-chamber, allowing a portion of the compressed air in the reservoir to flow into the chamber. If the latter contains an excess of air, its pressure against the movable lid keeps the valve closed.

The apparatus, when under water, works in the following manner. In the act of inhalation, the diver withdraws a certain amount of air from the chamber; exterior pressure is then exerted on the movable lid, which falls, causing the conical valve to open. Air passes in from the reservoir, reëstablishing an equilibrium of pressure between the interior of the air-chamber and the surrounding water, and the conical valve returns to its seat, intercepting the communication between the reservoir and chamber until another inspiration causes the operation to be repeated. As the air is expelled from the lungs, the valve of the respiratory tube before described permits its escape into the water.

It is evident that the uniformity of action in this apparatus depends entirely upon the respiration of the diver, however irregular may be the action of the air-pump; the workman receives precisely the quantity of air he requires, and at a pressure exactly equal to that of the medium by which his body is sur-



DIVING-BELL AND CORAL-DIVERS.

PLATE XIV. GIBRALTAR. *See page* 714.

rounded. The pump which supplies air to the reservoir is so constructed that liability to leakage diminishes with the pressure, and the air is compelled to traverse two layers of water before entering the reservoir, rendering it much cooler than it would otherwise be in its greatly compressed state; it is farther cooled by expansion in passing from the reservoir into the air-chamber.

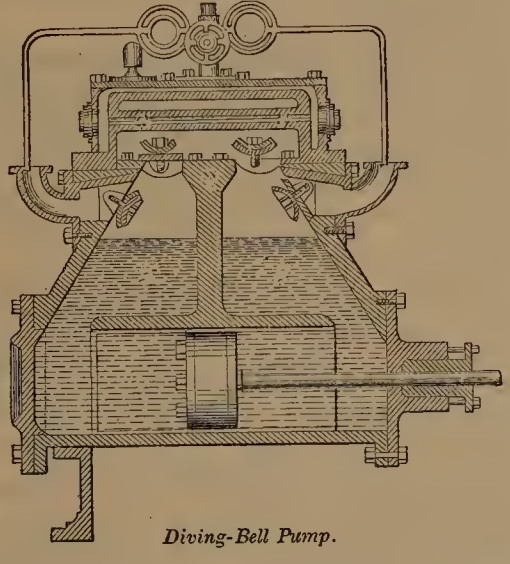
An important advantage possessed by this apparatus is that the expired air rises in bubbles to the surface. So long as the diver breathes regularly, the intervals between the appearance of the bubbles is sensibly equal. If they come more rapidly or more slowly than usual, it is a sign that something abnormal is going on. If they cease altogether, the diver must have ceased breathing, and should be hauled up immediately.

In the old forms of diving-dress the air filled the space between the body of the diver and his impervious clothing, the expired air escaping by a small valve in the helmet, through which any excess of air also escaped. Irregularity in the action of the pump caused also irregularities in the escape of the bubbles, and thus the assistants might for a long time unconsciously continue to send air to a corpse. In the new apparatus, the appearance of the bubbles indicates the safety of the diver, and the assistants on the watch are at any time warned of his danger by their nonappearance.

The armor employed in connection with the breathing-apparatus only serves to defend the diver from cold, and may therefore be made much lighter, allowing greater freedom of motion. See ARMOR, SUBMARINE.

Div'ing-bell Pump. A pump having a casing divided by a vertical partition into two chambers,

Fig. 1678.



Diving-Bell Pump.

which are provided with inwardly and outwardly opening valves. The chambers are kept partially filled with water, which, together with air, is admitted to each through the inwardly opening valves, and expelled through those opening outwardly, to supply the bell with fresh air. This is effected by the alternate reciprocations of a piston working in the open-ended cylinder, which, at each stroke, draws a portion of the water from one of the chambers into the cylinder, lowering its level in that chamber, and permitting the air to enter through the inwardly opening valve; the return-stroke causes the water to rise, forcing some of it, together with the air, into an exterior chamber, whence it is carried to a condenser, and thence, through a tube, to the bell.

Div'ing-dress. A waterproof clothing and helmet for those who make submarine explorations. See ARMOR, SUBMARINE.

Di-vis'ion-plate. The disk or wheel in the gear-cutting lathe, which is pierced with various circular systems of holes; each circle represents the divisions of a circumference into a given number of parts.

Do'be-rein'er's Lamp. An instrument invented by Professor Dobereiner, in Jena, in 1824, for obtaining light by the projection of a jet of hydrogen upon a piece of spongy platinum. See HYDROGEN LAMP.

Dock. 1. (*Hydraulic Engineering.*) An artificial excavation or structure for containing a vessel for repairs, loading, or unloading.

Docks are of various kinds. See

Wet-dock.	Floating-dock.
Dry-dock.	Hydraulic-dock.
Graving-dock.	Slip-dock.
Screw-dock.	Shipbuilding-dock.
Sectional-dock.	

The docks (*navalia*) of Rome were used for building, laying up, and refitting ships. They were attached to the emporium outside of the Porta Trigemina, and were connected with the Tiber. They were included within the walls of the city by Aurelian.

The Athenian docks in the Piræus cost 1,000 talents.

"They have a design to get the king [Charles II.] to hire a dock for the herring busses to lie up in."— PEPYS, 1661.

"Sir N. Crisp's project of making a great sasse [sluice or lock] in the king's lands about Deptford, to be a wett dock to hold 200 sail of ships."— IBID, 1662.

Of the docks of London: —

Pitt laid the foundation-stone of the "West-India" August 15, 1800; opened in 1802. "London" docks, built 1802 – 5. "Victoria," 1855. The Liverpool and Birkenhead docks, 1810 – 57.

2. (*Harness.*) The divided piece forming part of the crupper, through which the horse's tail is inserted.

Dock'er. A stamp for cutting and piercing dough in making crackers or sea-biscuit.

Doc'tor. A part in a machine for regulating quantity, adjusting, or feeding: —

a. (*Paper-making.*) A steel edge on the pressure-roll of a paper-machine to remove any adhering fibers.

b. (*Steam-engine.*) An auxiliary steam-engine to feed the boiler.

c. (*Calico-printing.*) A scraper to remove superfluous coloring-matter from the cylinder.

The *color-doctor* of a calico-printing machine, which wipes superfluous color from the face of the engraved roller.

The *lint-doctor*, which removes fluff and loose threads from the said roller.

The *cleaning-doctor*, which wipes clean the surface of the roller.

Dod. (*Tile-making.*) A piece affording an annular throat through which clay is forced, to make drain-pipe. See TILE-MACHINE.

Dodg'ing. Said of mortises, when they are not in the same plane at the hub. By spreading the butts of the spokes where they enter the hub, *dodging* on each side of a median line, alternately, the wheel is stiffened against lateral strain. The wheel is said to be *staggered*.

Doe'skin. (*Fabric.*) A single width fine woolen cloth for men's wear; not twilled.

Dof'fer. A comb or revolving card-covered cylinder in a carding-machine, which strips the fleece or sliver of fiber off the main card-wheel after the filaments have passed the series of smaller carding-rollers and the flat cards.

It is usually a comb with very fine teeth, which penetrate slightly between the wire teeth of the card as the comb moves downward.

Doff'ing-cyl'in-der. A cylinder clothed with cards which are presented in such direction and at such a rate of motion to the main card-cylinder as to remove the fibers from the teeth of the latter.

The doffing-cylinder assumes one of three forms:—

1. *Continuous clothing;* removing a perfect fleece of the width of the machine. Such is the *doffer* of the *scribbling-machine*, which yields a continous *lap* or *fleece*.

2. *Longitudinal bands of card clothing;* removing slivers of a width determined by the breadth of the bands and of a length equal to that of the *doffer*. Such is the doffer of the *slubbing-billy*. See SLUBBING-MACHINE.

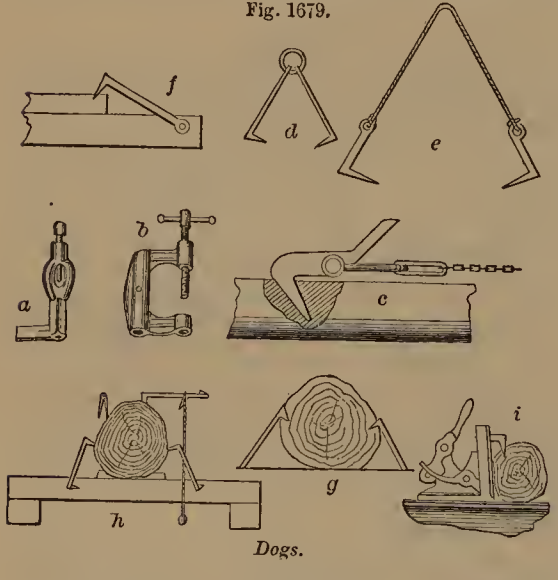
3. *Circumferential bands or rings of card-clothing;* removing narrow, continuous slivers, which pass to the *condenser*, whereby they are compacted and brought to the condition of *slubs*. Such is the *doffer* of another form of SLUBBING-MACHINE (which see).

Doff'ing-knife. A blade of steel toothed at its edge like a fine comb, and vertically reciprocated by a crank tangentially to the teeth of the *doffer* in a carding-machine, in order to remove therefrom a fine fleece of carded wool which is gathered into a sliver. See DOFFER.

Dog. A hold-fast.

A device with a tooth which penetrates or grips an object and detains it. The analogy and inference of the name is that the device has a *tooth* and *bites*.

Fig. 1679.



Dogs.

1. (*Pile-driving.*) A grappling iron or grab, usually with jaws, and adapted to raise the *monkey* of a pile-driver. When the jaws open, the object is dropped or released. See PILE-DRIVER.

2. (*Well-boring.*) A grab for clutching well tubes or tools, in withdrawing them from bored, drilled, or driven wells. See GRAB.

3. (*Turning.*) A clamp fastened to a piece suspended on the centers of a lathe, and by which the rotation of the chuck or face-plate is imparted to the piece to be turned (*a b*, Fig. 1679).

4. A *click* or *pallet* adapted to engage the teeth of a ratchet-wheel, to restrain the back action. A *click* or *pawl*. See WINDLASS; RATCHET.

5. (*Machinery.*) *a.* The converging set screws which establish the *bed-tool* of a punching-press in direct coincidence with the punch.

b. A contrivance for holding the staff to the rest, chuck, or carriage, while being cut, sawed, planed, or drilled.

c. An adjustable stop placed in a machine to change direction of motion, as in the case of feed-motion, or in *jacking*, *shaping*, or *planing* machines.

6. (*Hoisting and Hauling.*) *a.* A grappling-iron (*c*) with a fang which is driven into an object to be raised or moved.

In the continuous system of feed in saw-mills, the chain has a number of dogs attached to different portions of its length. Dogs are also used for securing and towing floating logs and in shifting or loading logs on the ground or carriage.

b. A *ring*-dog or *span*-dog (*d*); two dogs shackled together by a ring, and used for hauling or hoisting.

c. *Sling*-dogs (*e*); two dogs at the end of a rope and used in hoisting barrels. A *span-shackle*.

7. A *bench*-dog (*f*) is a clamp, and holds the timber by its tusk.

8. (*Sawing.*) A rod on the head or tail block of a saw-mill carriage, by which the log is secured in position. The dog (*g*) is pivoted to the block, and its tooth is driven into the log. It varies in form on the head and tail blocks respectively.

In *h* and *i* respectively are shown other forms of the saw-mill dog. See also CIRCULAR SAW; HEAD-BLOCK.

9. (*Shipbuilding.*) The last detents or supports knocked away at the launching of a ship. A *dog-shore*.

10. (*Locksmithing.*) A projection, tooth, tusk, or jag in a lock, acting as a detent. Especially used in tumbler-locks.

11. An *andiron*.

Dog and Driv'er Chuck. A chuck having two parts. The dog slips upon and is fastened by a set screw to the object to be turned. The driver is attached to the lathe-mandrel, and has a projecting arm which comes in contact with the dog, and causes it and the work to revolve with the mandrel. See DOG (*a b*, Fig. 1679).

Dog-bolt. The bolt of the cap-square over the trunnion of a gun.

Dog-cart. A sportsman's vehicle having shafts and two wheels, with a box beneath the seat for setters or pointers.

Dog'ger. (*Nautical.*) A two-masted fishing-vessel with bluff bows and used on the Dogger Bank, an extensive shoal in the center of the North Sea. It is about 80 tons burden, and has a well in the middle to bring fish alive to shore.

Dog-hook. 1. A bar of iron with a bent prong to drive into a log. See DOG.

2. A wrench for unscrewing the coupling of iron boring-rods. A *spanner*.

Dog-leg Chis'el. A crooked-shanked chisel used in smoothing the bottoms of grooves.

Dog-legged Stairs. A flight of stairs without any well-hole, and used in confined situations. The flight goes up, winds in a semicircle, and then mounts again in a direction parallel to the first.

Dog-muz'zle. A wire cage over the nose and jaws, to keep a dog from biting; or a strap around the jaws, to keep them shut.

Dog-nail. A large nail with a projecting tooth or lug on one side; used under certain circumstances by locksmiths and carpenters.

Dog-nose Vise. (*Locksmithing.*) A hand-vise

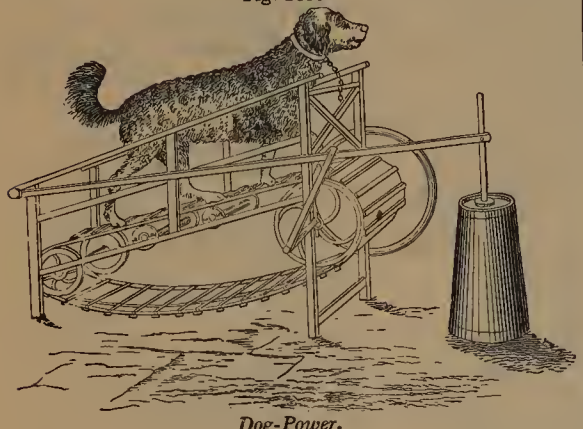
with long, slender, pointed jaws. Called also *pig-nose* vise.

Dog-pow'er. A machine by which the weight of a dog in traveling in a drum or on an endless track is made to rotate a spit, or drive the dasher of a churn.

The turnspit-dogs of the last and previous centuries ran on the inside of a hollow tread-wheel, which rotated with their weight and communicated motion by a band to the spit. See ROASTING-JACK.

In the modern dog-powers, as in the example, the animal walks on an endless chain-track, which slips

Fig. 1680



Dog-Power.

to the rear, rotating a drum which oscillates an arm, and vertical reciprocation is given to a lever and the churn-dasher.

Dog-shore. (*Shipbuilding.*) One of the two struts which hold the cradle of the ship from sliding on the slip-ways when the keel-blocks are taken out. The lower end of each *dog-shore* abuts against the upper end of the *rib-band* of the *slip-way*, and the upper end against the *dog-cleat*, which is bolted to the side of the *bilge-way*. Beneath each *dog-shore* is a small block called a *trigger*.

In launching, the triggers are removed, the *dog-shores* knocked down, and the ship-*cradle* freed, so that, carrying the vessel, it slides down the *slip-ways*. The signal for launching is, "Down dog-shores." See LAUNCH.

Dog's-tooth. A sharp steel punch used by marble-workers.

Dog-stop'per. (*Nautical.*) A stopper put on to the cable to enable it to be bitted, or to permit the *messenger* to be *flected*.

Fig. 1681.

Egyptian Doll.

Dog-vane. (*Nautical.*) A small vane, made of cork and feathers, placed on the weather-rail as a guide to the helmsman when sailing on a wind.

Doi'ly. (*Fabric.*) Formerly, a species of woolen stuff; now, a table-napkin.

Doll. A child's toy-baby. Made of stuffed cloth, wood, india-rubber, etc. The jointed wooden dolls are a marvel of cheapness, and are made by the peasantry of Europe. See TOY.

Among other curiosities of the former inhabitants of Egypt are a number of dolls which are found in the tombs, and also are represented on the painted walls. Just as with us, some are rough, some comical, and some are made as nearly symmetrical as the artist was able.

Dol'ly. 1. (*Metallurgy.*) A perforated board placed over a tub containing ore to be washed, and which, being worked by a winch-handle, gives a circular motion to the ore.

2. (*Piling.*) An extension-piece on the upper end of a pile, when the head of the latter is beyond the reach of the *monkey*. Otherwise called a *punch*.

3. A hoisting-platform.

4. A tool with an indented head for shaping the head of a rivet. A *snap-head*.

Dol'ly-bar. A block or bar in the trough of a grindstone which is lowered into the water to raise the latter against the face of the stone by displacement.

Dol'ly-tub. (*Metallurgy.*) A vertical tub in which metalliferous slimes are washed. It has a vertical shaft and vanes turned by a crank-handle, like some kinds of churns.

Dol'phin. 1. (*Ordnance.*) One of the handles of an old-fashioned brass gun, nearly over the trunnions, and by which it is lifted.

2. (*Nautical.*) *a.* A bollard post on a quay to make hawsers fast to.

b. An anchored spar with rings, serving as a mooring-buoy.

c. A strap of plaited cordage acting as a preventer on a yard, to sustain it in case the slings are shot away.

3. (*Hydraulics.*) The induction-pipe of a water-main, and its cover, placed at the source of supply.

Dol'phin-strik'er. (*Nautical.*) A spar depending from the end of the bowsprit. It affords a strut for the martingales of the *jib-boom* and *flying-jib-boom*.

Dome. 1. (*Architecture.*) A vault on a circular plan. It is usually hemispherical in form, but is susceptible of a prolonged or oblate spheroidal variation.

In the data following, the hight given is that of the apex above the ground.

The dome of the Pantheon at Rome is a hemisphere 142 feet in diameter, 143 feet high above the floor of the rotunda.

The dome of St. Sophia at Constantinople is an oblate semi-spheroid 104 feet in diameter, 201 feet high. It is said to be built of earthenware and pumice-stone, not of cut stone. It was built in the sixth century.

The dome in the Duomo of Florence was built by Brunelleschi in 1417. It is of brick, octagonal in plan, 139 feet in diameter, and 310 feet in hight.

The dome of St. Peter's, at Rome, was built at the close of the sixteenth century, from designs left by Michael Angelo. It is 139 feet in diameter, 330 feet high.

The dome of St. Paul's, at London, by Sir Christopher Wren, is not masonry, but a shell inclosing the brick cone which supports the lantern. It is 112 feet in diameter, 215 feet high.

	Internal Diameter.	Internal Hight.
Mosque of Achmet, Constantinople	92	120
Duomo at Milan . . .	57	254
Hall aux Blés, Paris, by Moulineau	200	150
St. Isaac's, Petersburg . . .	96	150
Baths of Caracalla . . .	112	116

The dome of the Capitol, Washington, is 287 feet 11 inches above the base-line of the east front. The greatest diameter of the dome at the springing is 135 feet 5 inches. The weight of iron in the dome and tholus is 8,009,200 pounds. The rotunda is 95.5 feet in diameter, and its hight from the floor to the top of the canopy is 180.25 feet.

The central rotund of the Vienna Exposition building, 1873, springs from a circular façade of piers 426½ feet, English, in diameter; within which is a gallery covered with its own roof; from the interior perimeter of the gallery rises a conical roof

surmounted by a lantern 105 feet in diameter, and this by a second lantern and cupola rising to a hight of 300 feet above the ground.

2. (*Steam-engine.*) The steam-chamber above some forms of boilers, as the locomotive. It frequently has an arched crown.

3. (*Railroad.*) The elevated upper section of a passenger-car projecting above the general level of the roof, forming a space for ventilation, light, and ornament.

Dome-cov'er. (*Steam-engine.*) The brass or copper cover over the dome of a locomotive, which serves to prevent the radiation of heat.

Do-mes'tic. (*Fabric.*) Bleached and unbleached, unprinted and undyed cotton cloths of the ordinary grades for common use.

Do-mes'tic Ap-pli'an-ces. The implements and conveniences appertaining to the household. Among them are the following, which are considered under their respective heads: —

Almond-peeler.
Andiron.
Apple-corer.
Apple-parer.
Apple-quarterer.
Ash-leach.
Ash-sifter.
Baby-jumper.
Baby-walker.
Baker.
Basket.
Bean-sheller.
Bed.
Bed-bottom.
Bedstead.
Bedstead-fastener.
Bird-cage.
Biscuit-machine.
Boiler. Culinary
Boot-jack.
Bottle-cleaner.
Bottle-screw.
Bread-cutter.
Bread-making machine.
Broiler.
Broom.
Broom-handle.
Broom-head.
Brush. See Brushes.
Butter-dish.
Butter-mold.
Butter-tongs.
Butter-worker.
Cake-cutter.
Cake-mixer.
Candle-snuffers.
Can-opener.
Carpet-beater.
Carpet-cleaner.
Carpet-fastener.
Carpet-stretcher.
Carpet-sweeper.
Caster.
Carving-table.
Chair.
Chamber-closet.
Charcoal-furnace.
Cheese-cutter.
Cherry-stoner.
Chopping-machine.
Clothes-brush.
Clothes-dryer.
Clothes-frame.
Clothes-horse.
Clothes-line.
Clothes-line hook.
Clothes-line reel.
Clothes-pin.
Clothes-press.
Clothes-sprinkler.
Clothes-tongs.
Clothes-wringer.
Coal and ash sifter.
Coal-scuttle.
Coat-hook.
Coffee-mill.
Coffee-pot.
Coffee-roaster.
Colander.
Comb.
Comb-brush.
Cooking-range.
Cooking-stove.
Corer and slicer.
Cork-press.
Cork-pull.
Corkscrew.
Corn-cake cutter.
Corn-grater.
Corn-popper.
Couch.
Cracker-machine.
Cradle.
Cream-freezer.
Crimper. Hair
Crimper. Ruffle
Crumb-remover.
Curling-iron.
Desk.
Dish-heater.
Dish-holder.
Dish-rack.
Dish-warmer.
Dish-washer.
Docker.
Domestic-press.
Door-mat.
Dough-kneader.
Dough-mixer.
Dough-trough.
Dredging-box.
Dumb-waiter.
Dust-pan.
Earth-closet.
Egg-assorter.
Egg-basket.
Egg-beater.
Egg-boiler.
Egg-carrier.
Egg-detector.
Egg-tongs.
Extinguisher. Fan.
Feather-renovator.
Fender. Fire-irons.
Fire-screen.
Fish-kettle.
Fish-slice.
Flat-iron.
Flat-iron heater.
Flour-sifter.
Fluting-iron.
Fluting-machine.
Foot-stool.
Fork.
Freezer. Fruit-jar.
Frying-pan.
Furniture-pad.
Furniture-spring.
Furniture-tip.
Gong. Grater.
Griddle.
Gridiron.
Hastener.
Hat-rack.
Head-rest.
Hearth-brush.
Honey-strainer.
Hospital-bed.
Ice-chest.
Ice-cream freezer.
Ice-crusher.
Ice-cutter. Ice-pick.
Ice-pitcher. Ice-plane.
Ice-safe. Ice-tongs.
Ironing-board.
Ironing-machine.
Italian-iron.
Jar. Fruit
Kneading-machine.
Knife-board.
Knife-cleaning machine.
Knife-polisher.
Knife-rest.
Knife-sharpener.
Knock-down chair.
Ladle.
Lamp-chimney cleaner.
Lamp-chimney tongs.
Lamp-stove.
Laundry.
Laundry-stove.
Lemon-squeezer.
Line-clamp.
Looking-glass.
Mangle. Mat.
Matches. Match-safe.
Mattress.
Meal-sieve.
Meat-chopper.
Meat-crusher.
Meat-cutter.
Meat-hook.
Meat-mangler.
Meat-saw. Meat-spit.
Meat-tub.
Milk-can.
Milking-machine.
Mincing-knife.
Mincing-machine.
Mop.
Mop-head.
Mop-wringer.
Music-stand.
Musquito-bar.
Musquito-canopy.
Night-chair.
Nut-cracker.
Nutmeg-grater.
Oyster-opener.
Palliasse.
Peach-parer.
Peach-stoner.
Pea-sheller.
Percolator.
Piano-stool.
Pie-board.
Pillow.
Pinking-iron.
Piping-iron.
Plate-rack.
Plate-warmer.
Pliant.
Portable furnace.
Portfolio-stand.
Potato-masher.
Potato-washer.
Press.
Pressing-board.
Preserve-jar.
Quilting-frame.
Raisin-seeder.
Refrigerator.
Rimmer. Pie
Roasting-jack.
Rolling-pin.
Sabotiere.
Sad-iron.
Sad-iron heater.
Safe. Meat
Sausage-machine.
Sausage-stuffer.
Scoop.
Scrubbing-brush.
Scrubbing-machine.
Scuttle. Settee.
Sewing-box.
Shaving-cup.
Sieve. Sifter.
Skillet.
Skimmer. Slicer.
Smoothing-iron.
Smoothing-stone.
Snuffers. Sofa.
Spittoon. Spoon.
Steak-crusher.
Steam-cooking apparatus.
Steamer.
Step-ladder.
Stool.
Stoves and heating appliances (which see).
Table.
Toaster. Tongs.
Tray.
Tumbler-washer. Urn.
Vegetable-chopper.
Vegetable-cutter.
Vegetable-grater.
Vegetable-slicer.
Vegetable-washer.
Waffle-irons.
Waiter.
Warming-pan.
Wine-cooler.

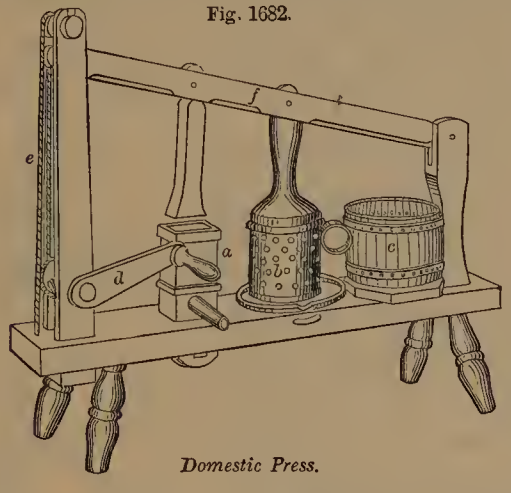
Washboard.
Wash-boiler.
Washing-machine.
Washing-shield.
Water-cooler.
Wire mattress.
Work-basket.
Wringer.

Do-mes'tic Boil'er. One for heating water on a somewhat large scale for the household. Such are made of sheet-metal, to set upon the top of a stove occupying two of the stove-holes; or, made of cast-iron, they form reservoirs as a permanent attachment to the stove. See WASH-BOILER; RESERVOIR-STOVE.

Dioscorides mentions tinned boilers. Pliny also treats of tinning copper vessels. Boilers with faucets have been disinterred at Herculaneum.

Do-mes'tic Press. One for household use for pressing honey, lard, tallow, cheese, sausage, or fruit.

Fig. 1682.



Domestic Press.

The press shown in the example has a sausage-stuffer *a* farthest from the pivoted end of the lever *f*. A lard-presser next, with a perforated tin hoop *b*. On the bench is also shown a platform and hoop *c* for fruit, which is substituted for the lard-hoop when required. *d* is a crank which operates the tackle and depresses the lever *f*.

Dom'ett. (*Fabric.*) A plain cloth, with cotton chain and woolen weft.

Do'ney. (*Nautical.*) A one-masted native vessel on the Coromandel coast, 70 feet long, 20 feet beam, and 12 feet hold.

Don'key-en'gine. (*Steam-engine.*) An auxiliary engine for working the feed-pump, hoisting in freight, etc.,— work unconnected with the propelling engines, and which may thus proceed when the main engines are stopped.

Don'key-pump. A steam-pump for feeding steam-engine boilers; frequently used for pumping in water during the cessation from working of the principal engine. It is used as a substitute for the feed-pump portion of the large engine; also used in breweries, distilleries, gas-works, tanneries, chemical works. One of the pumps is shown mounted on legs, another adapted to be bolted to a post or wall.

Doo'dle-sack. (*Music.*) The *bagpipe* (Ger. *dudelsack*).

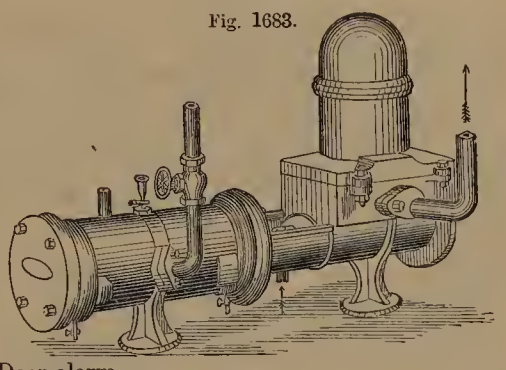
Dook. A wooden plug or block inserted in a brick or stone wall for the subsequent attachment of the finishing pieces.

Door. 1. An opening in a wall for a passage-way.

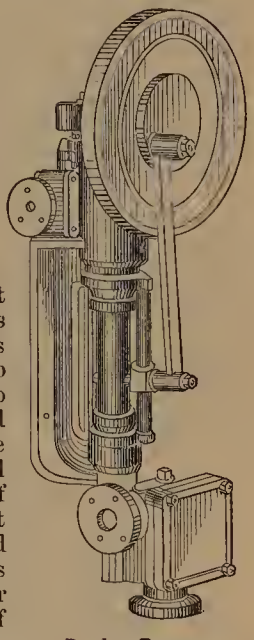
2. A frame or barrier closing said opening.

The word forms a part of many compound words, such as —

Fig. 1683.



Door-alarm.
Door-bell.
Door-case.
Door-fastener.
Door-knob.
Door-lock.
Door-nail.
Door-plate.
Door-spring.
Door-stone.
Door-stop.
Door-strip.
Door-way plane, etc.



Donkey-Pumps.

The doors of ancient Egypt and contemporary nations swung upon vertical pintles which projected from the top and bottom of the door into sockets in the lintel and threshold respectively. The commonest form of door had the pintle in the middle of the width, so that, as it opened, a way was afforded on each side of it for ingress or egress. This is much better than the villainous system of making the doors of churches, theaters, and assembly-rooms open inward, forming traps to catch the people when a stampede occurs from a fire or an alarm. It is but recent in our recollection, the account of the burning of a cathedral at Callao or some other city on the South American coast, when the building, decked out with paper and calico, in all the frippery of a saint's gala-day, was burned, with 800 miserable people,— women and children chiefly, for such are the principal patrons of churches in that land of Mestizoes.

It is not to be inferred that a simple valve swinging on a central axis was the only form of door, for in other structures we find the sockets near the posts, showing that the door turned upon an axis in the line of one of its vertical edges. Such doors, among the Romans, were fastened by bars or chains. Door-locks were known in Thebes centuries previous to the Augustan era of Rome, and some are to be found in the museums of Europe. See LOCK.

The street doors of Greek and Roman houses opened outward when formed of a single leaf, and an issuing citizen rang a bell to warn passengers in the street; or sometimes of a pair of leaves, each swinging on its own pintle and forming a double door. When doors were made to fold, they were swung inward; in this case one valve was hinged to another and swung back against its principal, the latter having pivots which turned in the threshold and lintel. Such doors were known in ancient Greece.

The doors of the residence of the Inca Huayna

Capac, in the vicinity of Cotopaxi, were similar to those of the Egyptian temples.

The doors of the oracle of Solomon's Temple were of olive-tree, and were "a fifth part of the wall." As the width of the house was 20 cubits, the doorway was about 6½ feet wide. The door was double. The outer door of the temple was of fir, and hung upon olive-tree posts. The doorway was about eight feet wide, and the double doors had each two leaves.

"The two leaves of the one door were folding, and the two leaves of the other door were folding."

It is not easy to find in any other very ancient author so clear a description of the proportions and construction of a building as is found in 1 Kings, vi.

A pair of doors have figured somewhat largely in the history of East Indian conquest. It is seldom that so much fuss has been made about a pair of doors since Samson took those of Gaza from their hinges, about 1120 B. C., and carried them to the top of a hill before Hebron. He took them "bar and all," not condescending to unlock them, but tearing them from their foundations.

The doors of the Temple of Siva, at Somnauth, a town of Guzerat, in Hindostan, were of sandal-wood, elaborately carved in correspondence with the other portions of the temple, which was an oblong hall 96 × 68 feet, crowned by a dome. When Mahmoud, of Ghizni, at the head of his Mohammedan hordes, invaded India (A. D. 1004), on a mixed mission of plunder and conversion, he mingled avarice with enthusiasm and lust, so as to afford a first-rate model for a demon to master Anacreon Moore, some 800 years afterward: —

> "'T is he of Ghizni, fierce in wrath
> He comes, and India's diadems
> Lie scattered in his ruinous path;
> His bloodhounds he adorns with gems
> Torn from the violated necks
> Of many a young and loved sultana;
> Maidens within their pure zenana,
> Priests in the very fane he slaughters,
> And chokes up with the glittering wrecks
> Of golden shrines the sacred waters"

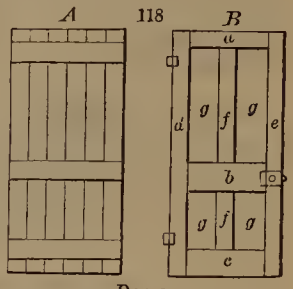
of the Ganges, of course. It must not be understood, however, that he failed to strip off the gold before he pitched these things into the muddy waters of the river, which delivers yearly into the Bay of Bengal 534,600,000 tons of solid matter.

Mahmoud, about 1024, after desolating Northern India for some years, came to Somnauth, and — omitting the details — plundered from the Temple of Siva "the destroyer" the rich offerings of centuries, carrying them and the doors of the temple to Afghanistan, where the latter were made the doors of his tomb.

Here they rested till 1842, when the English, stung to madness by the massacre of 26,000 soldiers and camp followers in the Kyber pass, in the month of January of the same year, invaded Afghanistan in force, and conquered Akbar Khan. Lord Ellenborough, inflated with an august desire for poetical, historical, and every other kind of retribution, seized upon the doors of Mahmoud's tomb as representatives of the success of Mohammedan domination, and carried them back to India proper, chanting a pæan whose refrain was "*the insult of eight hundred years is avenged,*" and commanding that the doors should be "transmitted with all honor" to the Temple of Siva. The British government, goaded on the one hand by Exeter Hall, and on the other by its fear of the two unmingled races who occupy Hindostan, found itself with an elephant on its hands, and stopped the gates at Agra, where they remain.

A, *batten*-door.
B, *panel*-door.
a, top-rail.
b, middle or lock rail.
c, bottom-rail.
d, hanging style.
e, lock style.
f, munnion or muntin.
g, panels.

Fig. 1684.



Doors.

In a six-panel door the rail next to the top rail is called the *frieze-rail.*

A panel wider than its hight is a *lying-panel.* If of equal hight and width, a *square panel.* If its hight be greater than its width, a *standing panel.*

Double-door; two pairs of folding-doors, hung on the angles of the apertures and opening toward the reveals against which they are hung.

Folding-doors; a pair whose respective leaves are hung on opposite corners of the aperture in the same plane, so that the styles meet in the center when closed.

Double-margin doors are made in imitation of *folding*-doors, the middle style being made double with an intervening bead.

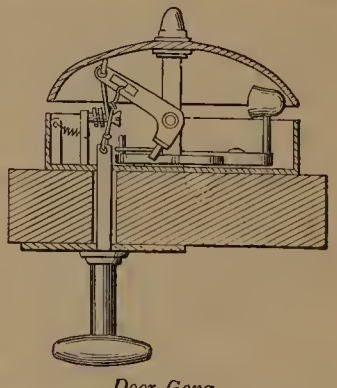
Sliding-doors are an improvement on folding; they slip into grooves in the partition.

A *proper-ledged* door is one made of boards placed side by side with battens called *ledges* at the back. With a diagonal piece at the back, in addition, it is said to be *framed and ledged.*

Door-a-larm'. A device attached to a door, to give an audible notice when the door is opened or tampered with. See BURGLAR-ALARM.

Door-bell. A bell attached to a door or door-post, or hung by a handle exposed outside of the door. In the example (Fig. 1685), the end of the lever, attached by a wire to the bell-pull, strikes a spur on the cam, one end of which, as it turns, forces down a bar attached by a bent wire to the hammer, till, the spur being released, the rebound causes the gong to be struck.

Fig. 1685.



Door-Gong.

In other instances, the bell or gong is sounded by the simple *turning* of the handle.

Door-case. The frame of a door, in which it swings and fits.

Door-fast'en-er. A portable contrivance for fastening a door. It usually consists of a piece jammed in between the door and the casing, having spurs which catch in the latter and a turn-button which engages against the door. In one example shown, it is a toggle-strut which thrusts against the door and the floor.

Door-frame. (*Carpentry.*) *a.* The structure in which the panels are fitted. It is composed of: —

The stiles, or upright pieces at the sides.

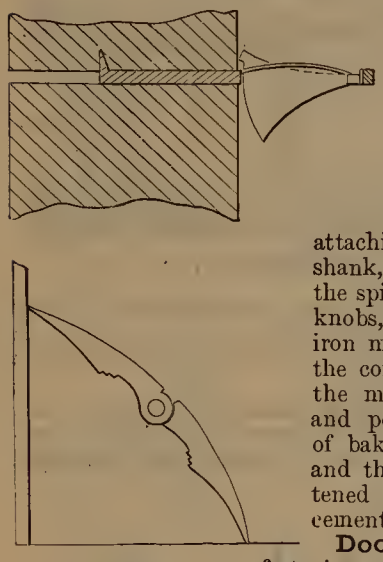
The munnions, or central upright pieces.

The bottom rail, the lock or central rail, and the top-rail. See DOOR.

b. The case into which a door is fitted.

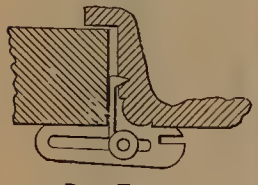
Door'i-ahs. (*Fabric.*) A cotton cloth made in India.

Fig. 1686.



Door-knob. The bulb or handle on the spindle of a door-lock. It is made of metal, glass, porcelain, or clay of various colors. Ingenuity is employed in devising means of attaching the knob to its shank, and the latter to the spindle. With glass knobs, the shank of thin iron may be passed into the congealing glass in the mold. With clay and porcelain the heat of baking is too great, and the shanks are fastened to the knobs by cement or fusible metal.

Door-lock. A door-fastening whose bolt is retracted by a key; differing from a latch or catch, in which the bolt is worked by the knob or handle.



Door-Fasteners.

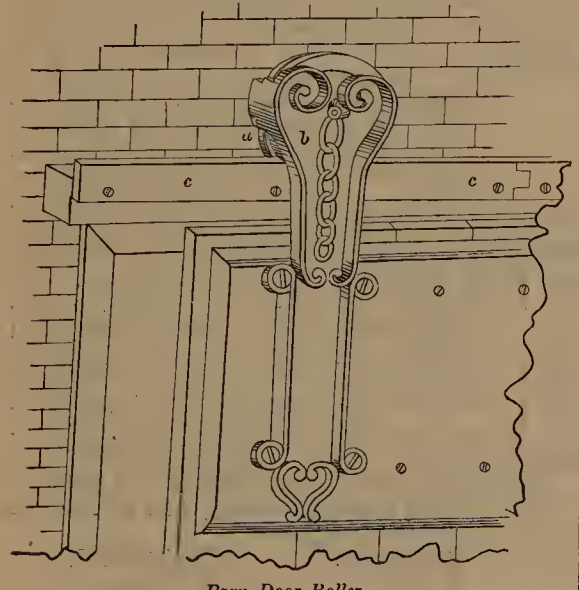
Door-locks are of various kinds, known usually by certain characteristic features of construction, sometimes from their purpose: —

Alarm-lock.
Box-lock.
Car-door lock.
Cell-lock.
Closet-lock.
Cross-bolt lock.
Dead-lock.
Front-door lock.
Jail-lock (see LOCK).
Janus-faced lock.
Lever-lock.
Mortise-lock.
Permutation-lock.
Reversible lock.
Rim-lock.
Safe-lock.
Sliding-door lock.

Door-mat. A texture for wiping the feet; made of tussocks of hemp, flax, or jute woven or tied into a fabric; also made of sedge, straw, rushes, or other common material.

Door-nail. The plug (or plate) on which a door-knocker strikes.

Fig. 1687.



Barn-Door Roller.

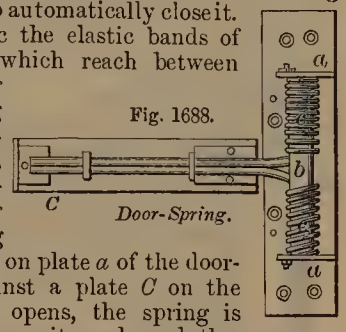
Door-plate. A name-plate on a door.

Door-roll'er. A suspension device for a sliding door. The roller *a* of the door-hanger *b* runs on a track plate or rod *c*. Used for doors of barns, warehouses, freight-cars, etc.

Door-spring. A spring attached to or bearing against a door, so as to automatically close it.

Of this nature are the elastic bands of vulcanized rubber, which reach between the top of the door and the lintel, being extended by the opening of the door, and, by contraction, closing it. In another form, a coiled spring is attached to a rod *b* on plate *a* of the door-post, and bears against a plate *C* on the door. As the door opens, the spring is coiled more tightly on its rod, and thus opposes a force which shuts the door when the person has passed. Another form is a torsion-spring; a wire whose ends are attached to the door and jamb so as to be twisted by the opening of the door.

Fig. 1688.



Door-Spring.

Door-stone. A threshold stone.

Door-stop. (*Carpentry.*) A knob or block on a skirting-board or floor, against which the door shuts. The object is to hold the door open or to catch it when opened clear back, and prevent the door-knob from bruising the wall.

Also a pad or strip on a door-case, against which the door shuts, to prevent slamming.

Door-strip. A strip attached near the lower edge of a door, to shut down tightly upon the threshold beneath when the door is closed. See WEATHER-STRIP.

Door'way-plane. The space included between the intrados of a large archway and the actual door of entrance.

Dop; Dopp. The copper cup in which a diamond is soldered when it is to be polished upon an iron *lap* or skive charged with diamond-powder. See DIAMOND-CUTTING.

Dor'mant-bolt. A concealed bolt working in a mortise in a door, and usually operated by a key, sometimes by a turning knob.

Dor'mant-lock. A lock having a bolt that will not close of itself.

Dor'man-tree. A large beam lying across the ceiling of a room, and serving as a joist. A *dormond* or *dormant-tree*.

Dor'mer-win'dow. (*Building.*) A window piercing a sloping roof, and having a vertical frame and gable of its own. The gable is sometimes in the plane of the wall, or is founded upon the rafters, sometimes a succession of stories in the roof are provided with dormers, as is commonly the case in some houses of Northern France, Belgium, and the Netherlands.

Dor'nock; Dor'nic. (*Fabric.*) A stout figured linen (*damask*), said to be named after the town in Scotland (Dornock) where it was made, but probably deriving its name from Tournay (Flemish, *doornic*), a frontier town of Belgium.

Dor'sel. (From Latin *dorsum*, the back.) 1. A pannier or basket to carry on the back.

2. *a.* A cover for a chair-back; hence,

b. Tapestry, or a screen at the back of a throne or altar.

c. Tapestry or wall hangings around the sides of the chancel of a church.

d. A canopy for a throne. A *lambrequin*.

3. A kind of cloth, used for the purposes stated.

Dor'sour. (*Fabric.*) Scotch cloth, used for hanging on walls of chapels and halls.

Do'ry. (*Nautical.*) A small, sharp, flat-bottomed boat, with very sloping sides, extensively employed in the British fisheries.

Dos'el. See DORSEL.

Dos'sil. (*Surgical.*) A small roll or pledget of lint of a cylindrical or ovoid form, to keep open a wound. A *tent.*

(*Printing.*) A roll of cloth for wiping off the face of a copper-plate, leaving the ink in the engraved lines.

Dotch'in. The Chinese steelyard. In Hong Kong, and other ports where Europeans trade, the beams are doubly graduated with circles of brass pins to mark British and Chinese weights.

Fig 1689.

Dotting-Pen.

Dots. (*Plastering.*) Nails driven into a wall to a certain depth, so that their protruding heads form a gage of depth in laying on a coat of plaster.

Dot'ting. A form of engraving in which geographical divisions on maps are shown by interrupted lines or series of dots. Done by a *roulette.*

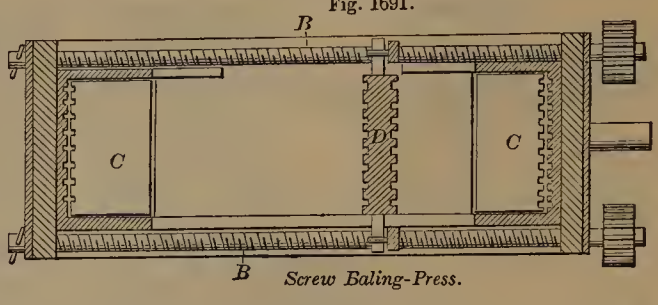
Dot'ting-pen. A pen having a roulette which makes dots or detached marks on the paper over which it is drawn. See ROULETTE.

Doub'le-act'ing Bal'ing-press. One which has two boxes in which the material is compressed; sometimes a single follower acts upon them alternately, in other cases two followers act simultaneously.

In the first example shown, the press is double-ended, each follower forming an abutment for the other as they are forced together by the toggle-levers. The toggle-levers *D* are suspended upon the cords or chains *F H*, forming flexible suspension-points, whereby bales of unequal size are pressed with equal force by the platens *C*. The view is a plan, seen from above. The rope winds upon the central post *G* to which the power is applied, and it thence passes over the sheaves *c c* on the ends of the cross-beam.

In Fig. 1691, a single follower *D* is used for two

Fig. 1691.

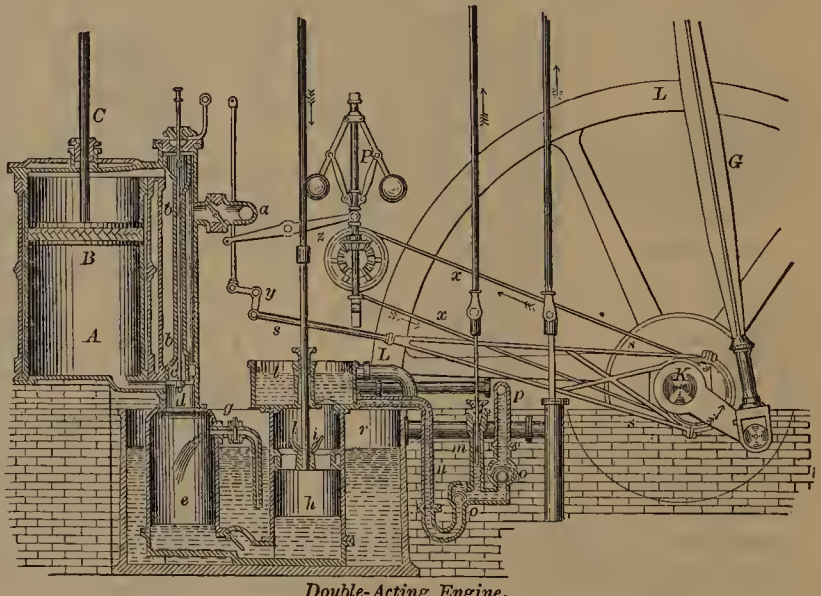


Screw Baling-Press.

press-boxes *C C* alternately, and is operated by four screws *B B* simultaneously driven, one at each corner, two showing in the illustration, which is a side elevation.

Doub'le-act'ing En'gine. (*Steam-engine.*) An engine in which both motions of the piston are produced by the action of live steam, which bears upon

Fig. 1692.



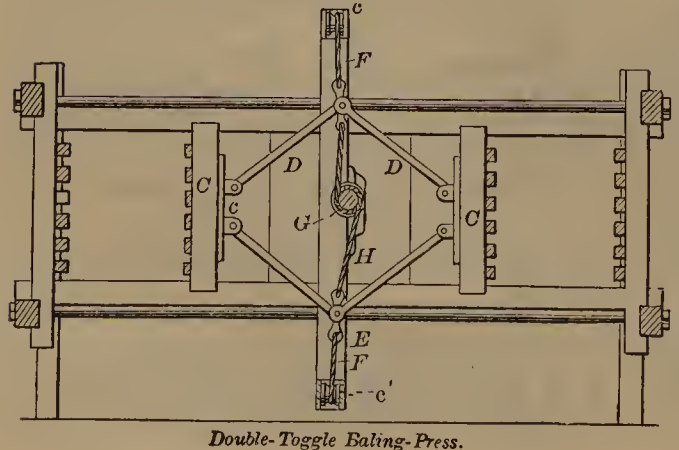
Double-Acting Engine.

the faces alternately. In contradistinction to *single-acting*, in which live steam is only admitted to one side of the piston, the weight of a pump-rod or the pressure of the atmosphere giving the return motion.

This form of engine was invented by Watt. The piston of the Newcomen atmospheric-engine, on which Watt was improving, was raised by steam at a moderate pressure, and depressed by the pressure of the atmosphere when the steam beneath the piston was condensed by a water-jet. Watt added the *separate condenser*, air-pump, and the steam-jacket to the cylinder, and then sought for means for keeping the atmosphere from the inside of the cylinder when the piston was depressed. He added the cylinder-cover, adopted the stuffing-box invented by Sir Samuel Morland, and admitted steam above the piston to occupy the space formerly filled with air. The steam retreated as the piston rose, and was afterwards utilized beneath the piston. Eventually the steam was regularly inducted above and below the piston alternately, in each case giving a positive pressure; here we have the *double-acting engine.*

A, cylinder. *C*, piston-rod.
B, piston. *G*, pitman.

Fig. 1690.

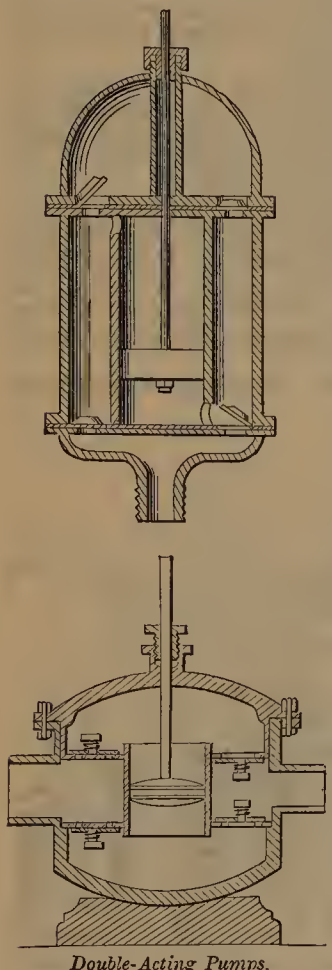


Double-Toggle Baling-Press.

K, main-shaft.
L, fly-wheel.
P, governor.
a, steam-induction pipe.
b, valve-chamber.
c, valves.
d, steam-eduction pipe.
e, condenser.
g, injection-cock.
h, air-pump.
i, discharge-valve.
l, hot-well.
m, feed-pump.
n, pipe to feed-pump.
o, valves to feed-pump.
p, feed-pipe to boiler.
r, air-pump cistern.
s, eccentric-rod.
x, band to governor.
y, bell-crank to valve-motion.
z, governor-gearing.

Doub'le-act'ing Pump. One which throws water at each stroke; contradistinguished from the ordinary lift-pump, in which the bucket only raises water at the up-stroke.

Fig. 1693.



In the upper pump (Fig. 1693), the side chambers have each of them induction and eduction valves.

In the lower pump (Fig. 1693), the cylinder has induction and eduction ports on opposite sides *E F*.

Double-Acting Pumps.

Doub'le-ac'tion. (*Music.*) In a pianoforte movement, an arrangement of a jointed upright piece at the back end of the key, used to lift the hammer instead of the stiff wire or lifter of the single-action. The piece is called a *hopper*, and engages in a notch on the under side of the hammer to lift it, but, escaping or hopping therefrom, allows the hammer to fall away immediately from the string.

Doub'le-bar'reled Gun. One having a pair of parallel barrels on the same stock; sometimes one is a rifle-barrel and the other a smooth-bore for shot. See FOWLING-PIECE; FIRE-ARM.

Doub'le-bass. (*Music.*) The largest and lowest bass instrument of the stringed instruments played with a bow. A *contrabasso*.

Doub'le-bead. (*Joinery.*) Two beads placed side by side and separated by a quirk. See MOLDING.

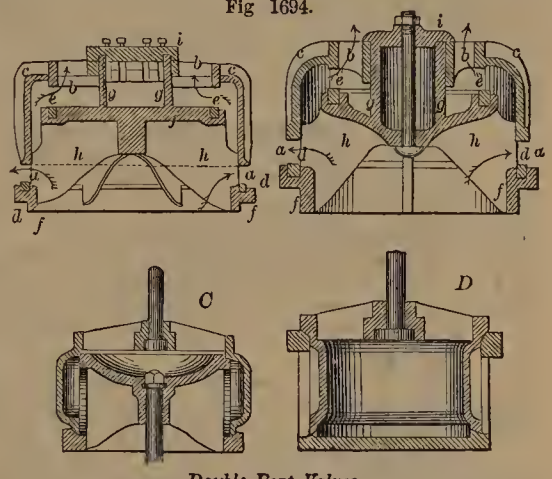
Doub'le-beat Valve. A valve so arranged that on opening it presents two outlets for the water, one at *a* and the other at *b*; in closing, the valve *c* drops upon the gun-metal rings *d e*, fixed in the seat *f*, which is of cast-iron; this is cast with a cylindrical portion *g*, which serves as guide to the valve, as do also the ribs *h h*. *i* is a cap which limits the throw of the valve.

The *double-beat valve* is extensively used in England for deep wells and for high lifts, such as the pumps of mines and water-works. It is so called from the fact that its lower edge *beats* upon a circular seat on the lower ring *d*, and a flange on its upper edge upon a *ring c*, on the upper plate of the valve-seat.

C is an external valve having inclined seats destitute of rings; *D* is an internal double-beat valve.

In the *double-beat* or *equilibrium* valve of the Cornish steam-engine, steam is conducted by a branch pipe into a larger perpendicular pipe between two conical valves placed in it and connected by a stem. When the valves rest on their seats, the steam will

Fig 1694.



Double-Beat Valves.

exert a pressure on the under side of the upper valve, tending to raise it; and on the upper side of the lower one, tending to keep it down; these two pressures in opposite directions thus neutralizing each other. It is therefore evident that, the pressures being nearly balanced, but a small amount of power is necessary to raise the valves from their seats, and by a slight opening a very large steam-way is afforded.

Doub'le-bit'ted Axe. The axe has two opposite bits or blades. It is an ancient form of battle-axe, being a favorite weapon with the Franks in the time of Clotaire, seventh century, and with the Danes in the time of Alfred the Great, ninth century.

Fig 1695.

Double-Bitted Axe.

It is also shown in the sculptures of Karnak, in Egypt.

The battle-axe of the Scythians in the time of Herodotus was double-bitted. It is the Sacan *sagaris*.

Scylax, an historian of an age preceding that of Herodotus, compared Egypt to a double-bitted axe, the neck which joins the two heads being at the narrow part of the valley in the vicinity of Memphis.

The double-bitted axe is found in the tumuli and barrows of North America. It is in three forms: 1, with a circumferential groove for the occupation of the withe or split handle to which it is lashed; 2, with an eye traversing the head; 3, with a socket for the handle. See AXE; BATTLE-AXE; HATCHET.

Doub'le-block. (*Nautical.*) A block with two sheaves which are ordinarily placed on the same pin, but rotate in separate mortises in the shell.

Other double-blocks have the sheaves arranged one above the other. See LONG-TACKLE BLOCK; SHOE-BLOCK; FIDDLE-BLOCK; SISTER-BLOCK.

Doub'le-bod'ied Mi'cro-scope. A microscope invented by Nachet, to enable several observers to view the same object simultaneously. The rays from the objective are divided by a prism; the separated rays received by two other prisms, and the respective pencils directed through the respective bodies of the instrument. The principle is similar to that of the BINOCULAR MICROSCOPE (which see).

Doub'le-cap. A flat (unfolded) writing or book paper, 17 × 28 inches.

Doub'le-chis'el. A tool with two chisel-edges to cut the ends of a mortise simultaneously, while the chip extends into the depression between the bits. It is used in mortising sash-bars for windows.

Fig. 1696.

Double-Chisel.

Doub'le-cloth Loom. One for weaving two sets of webs simultaneously. These may be connected at certain parts, and cut apart subsequently, and so form a series of under-garments.

In another form, the two webs are so knitted as to form a tube, being joined at their edges. At certain intervals, both webs are thrown into one flat web of double thickness, and then again separated, forming a tube as before. The completed web is then cut apart mid-length of the doubled portion, and also mid-length of the tubular portion, and the result is a number of bags with closed bottoms.

Doub'le-com'pass. An instrument whose legs are prolonged each way beyond the joint, so that either pair may be used; when the legs on one pair are double the length of the others, it answers as a *bisecting-compass*.

Doub'le-con'cave Lens. A lens both of whose faces are concave. See LENS.

Doub'le-con'vex Lens. A lens both of whose sides are convex, though they may differ in the radii of their curves. When the difference is as 6 to 1, it is a *crossed lens*. See LENS.

Doub'le-cut File. One which has *two* rows of teeth, crossing each other at an angle, in contradistinction to the *single-cut* or *float*, which has but one row.

Doub'le-cyl'in-der Press. (*Printing.*) A press with one form, and receiving paper from two cylinders.

Doub'le-cyl'in-der Print'ing-ma-chine'. A printing-press in which the form is placed on a flat bed and the impression taken by two cylinders, each of which alternately takes a sheet and receives an impression from the form while it is passing under them.

Doub'le-cyl'in-der Pump. One having two cylinders in which the pistons act alternately. They may be single-acting or double-acting, that is, the cylinder may receive and deliver water at and from each end. The pumps of Hero of Alexandria, 150 B. C., were all single-acting, but one of them at least had a double cylinder.

Dou'ble-cyl'in-der Steam-en'gine. A form of engine having two communicating cylinders of varying capacities; there are many modifications in the arrangements and modes of application of the steam.

The first engine of this character was that of Hornblower, in which two piston-rods were connected to the same arm of the walking-beam, but at different distances from its center of oscillation. As usually understood, the double-cylinder engine involves the use of the same steam in two cylinders consecutively; first at a relatively high pressure in a smaller cylinder, and then at a lower pressure in a larger cylinder.

Working steam expansively was invented by Watt and introduced in 1778.

Hornblower's expansive engine, patented in 1781, had two cylinders, of different sizes, their respective piston-rods being connected to the working-beam. An amount of steam of the capacity of the smaller cylinder was expended at each stroke, the upper part of the said cylinder receiving live steam from the boiler, and the lower part communicating with the space above the piston of the larger cylinder, where it was used expansively.

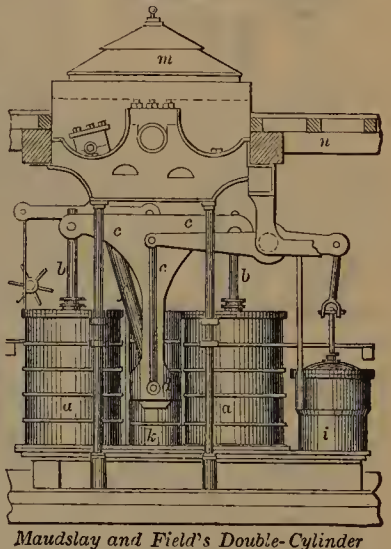
Hornblower's engine occupies one notable point in the history of the steam-engine, but was not adopted to any great extent.

Wolf, in his English patent of 1804, improved the arrangement, and his may be considered the progenitor of the numerous *compound* and *duplex* steam-engines which have proved so successful. See also Tippett's English patent, 1828.

This form of engine is extensively used in France, and the monster pumping-engines, with 144-inch cylinders, erected for draining the Haarlem Mere, from the designs of Gibbs and Dean, have double cylinders, one within the other, the outer being fitted with an annular piston. See DRAINING-ENGINE.

Maudslay and Field's double-cylinder steam-engine (English) is a form of engine having two cylinders, each of half the area necessary for the intended power, combined so as to form one engine, and placed so far apart as to leave a space between them for the connecting-rod, and the lower end of the T-shaped cross-head, to which the connecting-rod is attached. The piston-rods are attached to the horizontal extremities of the T cross-head, whereby the combined action of both pistons is applied to one crank of the paddle-shaft.

Fig. 1697.



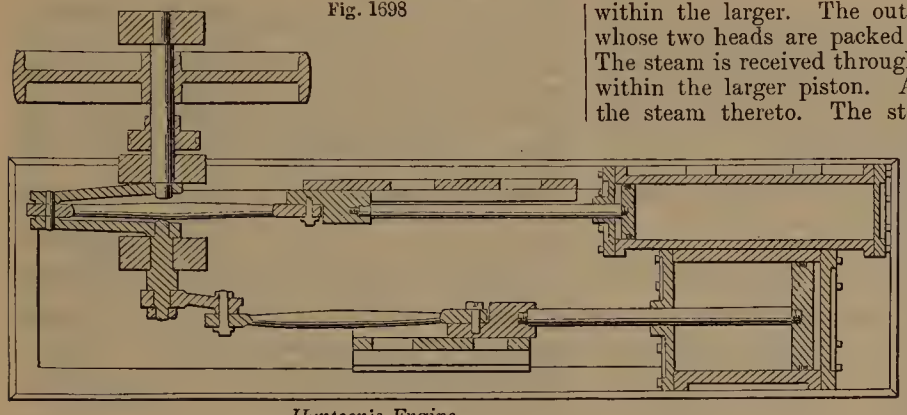
Maudslay and Field's Double-Cylinder Steam-Engine.

In the illustration, *a a* are the two connected working-cylinders, worked simultaneously by one slide-valve in the chamber *k*. *b b* are the piston-rods, the upper ends of which are attached by keys to the cross-head *c c c*. At the lower end of the cross-head is a slider *d* working between guides fixed on the outer surfaces of the cylinders. To this slider *d* one end of the connecting-rod *f* is attached, the other end of that rod being attached to the crank of the propeller-shaft. The air-pump *i*, feed-pump, and bilge-pump are worked by the lever, which is connected to the slider *d* by the rod. *m* is the skylight of the engine-room. *n* is a deck-beam.

This is one form of *direct-action steam-engine*, and was designed to obviate the use of a beam.

Fig. 1698 shows an arrangement in which two cranks on the same shaft and of different radii are

Fig. 1698

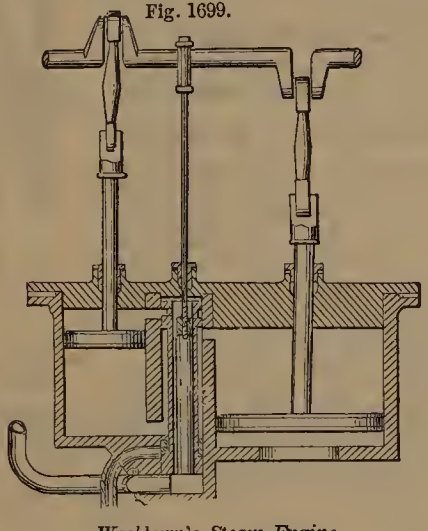


Hantoon's Engine.

respectively attached to pistons of varying diameter working in cylinders where the steam is used directly in one and afterwards expansively in the other.

In Fig. 1699, the cylinders are alongside each other. The rods of the pistons of the respective cylinders are united to the cranks, which have a relative angle of 180° on the same shaft. Steam ad-

Fig. 1699.

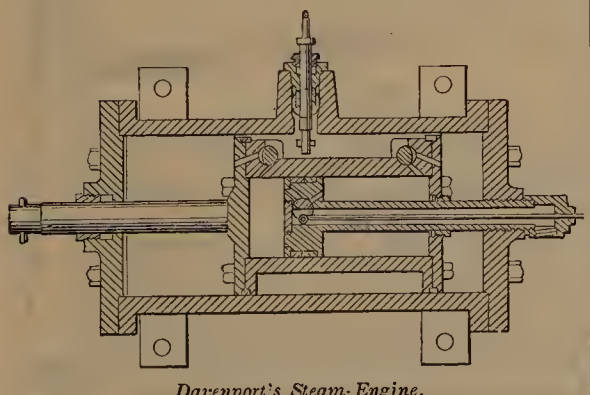


Washburn's Steam-Engine.

mitted above the smaller piston is used directly, and, the valve being raised, is cut off; and the annular space between the two disks forms a means of conveying the steam below the said piston, where it is equalized as to its effect on that piston, and above the larger piston, where it is utilized expansively.

In Fig. 1700, the smaller cylinder is contained

Fig. 1700.

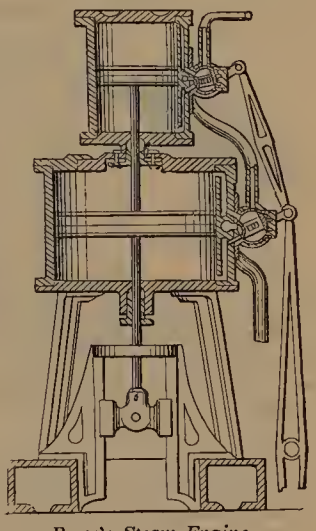


Davenport's Steam-Engine.

within the larger. The outer piston is a cylinder whose two heads are packed in the main cylinder. The steam is received through a hollow fixed piston within the larger piston. An axial pipe conducts the steam thereto. The steam first acts on the inner side of the outer piston-head, and exhausts to act expansively on the outer end of the outer piston. It then passes through the annular space between the side of the outer piston and the main cylinder to the exhaust-ports.

In another form the steam, after acting at a high pressure against the piston in the upper cylinder, is allowed to escape to work against the larger piston at a less relative pressure per square inch. The valves are connected so as to time the movements, and the steam acts alternately *above* both pistons and then *below* both pistons to combine the effects of the steam in the respective cylinders.

Fig. 1701.



Pease's Steam-Engine.

In Ellis's bisulphide of carbon engine, the heat of the exhaust-steam from one cylinder is made to boil the bisulphide of carbon, whose vapor is used in the second cylinder. See also COMPOUND-ENGINE; DUPLEX STEAM-ENGINE, etc.

Doub'le-dag'ger. (*Printing.*) A reference-mark (‡) next to the dagger (†) in order. Otherwise called a *diesis*.

Doub'le-door. Two pairs of folding-doors, hung upon the angles of the aperture and each swinging inward so as to open against the reveal. The inner pair is frequently covered with baize.

Dou'ble-d'or. A French style of jewelry; a plate of gold is soldered upon one of copper, the respective thicknesses being 1 and 11; the plate is then thinned by rolling, and worked up into the required form.

Doub'le-drill. A drill with two cutters, making a countersunk hole, so that the head of the screw or rivet placed therein shall not protrude.

Doub'le-draw'ing Pen. A draftsman's pen to rule two lines at once.

Doub'le-drum. (*Music.*) A large drum beaten at both ends. In contradistinction to other drums in which but one head is beaten; as, *side*, *snare*, and *kettle* drums. See DRUM.

Doub'le-el'e-phant. A size of drawing or flat writing-paper, measuring 26 × 40 inches.

Doub'le-end'ed Bolt. A bolt having a screw-thread on each end for receiving a nut. It is used for binding together three parts or pieces independently of each other. (See 5, Fig. 768.)

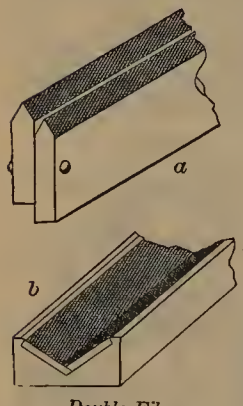
Doub'le-ex-pan'sion Steam-en'gine. A form of engine in which steam, admitted to act upon a piston of relatively small area and cut off at a certain part of the stroke, so as to work expansively

from that point to the end of the stroke, is then admitted to the face of a larger piston, where it undergoes a farther expansion. Such is the Allen engine (English), which has a large trunk-piston having two annular steam-spaces between the trunk and cylinder, affording two annular pistons of relatively small area; the ends of the trunk, which are of larger area, constituting two other piston-heads to receive the force of the steam at the second expansion. See also DOUBLE-CYLINDER STEAM-ENGINE.

Doub'le-faced. (*Joinery.*) A term applied to an architrave, or the like, having two faces.

Doub'le-file. A compound file (*a*) made of two files riveted together, one edge projecting beyond that of the other. Used by cutlers and gun-makers in checkering their work, as on the *small* of the gun-stock.

Fig. 1702.



Double-Files.

Cooper's double-file (*b*) is used for sharpening pencils, etc.

Doub'le-flu'id Bat'ter-y. A galvanic battery in which two fluids are used as exciting liquids. They are kept apart by a porous cup, as in the Daniell's battery, or by gravity, as in Callaud's (see *infra*). Daniell was the inventor of this form of battery, and received therefor the "Copley" medal of the Royal Society in 1837. He used sulphuric acid in a porous cup placed in a glass cup containing sulphate of copper.

Bunsen's, Grove's, and Callaud's are also double-fluid batteries. The name is used in contradistinction to the *single-fluid* batteries, such as the original Volta, the Cruikshank, Babbington, and Wollaston.

The gravity-battery is a double-fluid battery in which the porous cup is dispensed with, the difference in the specific gravity of the fluids used keeping them separate. Often called the "Callaud battery," after the name of the inventor.

Doub'le-floor. (*Carpentry.*) One in which both binding and bridging joists are employed. A *double-framed* floor.

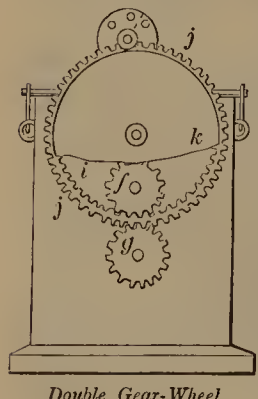
Doub'le-fur'row Plow. One striking two furrows at once. A *gang* or *double* plow.

Doub'le-fut'tocks. (*Shipbuilding.*) Timbers in the cant-bodies extending from the deadwood to the run of the second futtock-head.

Doub'le-gear. The nests of variable-speed gear-wheels in the head-stock of a lathe. *Back-gear.*

Doub'le Gear-wheel. A wheel which has two sets of cogs of varying diameter; these may drive two pinions, or be driven of one and drive the other. In the example, the wheel *j* drives the two pinions *f g*. The cover *k* is shown as partially broken away to expose the inner gear and the pinion *f*.

Fig. 1703.



Double Gear-Wheel.

Doub'le Half-round File. A file whose sides are curved, the edges forming cusps; the arcs of the sides being much less than 180°. Used for dressing or *crossing-out* balance-wheels, and hence known as a cross-file. The convex edges have usually different curvatures. See FILE.

Doub'le-ham'mer. (*Metallurgy.*) A forging device for operating upon a bloom or puddler's ball, striking it upon opposite sides simultaneously. See Grüner's "Manufacture of Steel," Van Nostrand, 1872; page 152 *et seq.*, and plates v, vi.

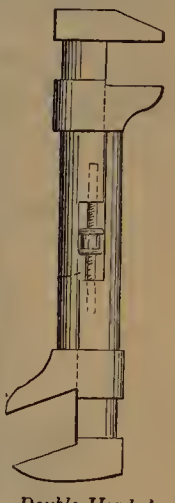
Doub'le-head'ed Rail. (*Railroading.*) A rail whose edges are bulbous and counterparts, so that when one is worn the other may be placed uppermost.

This rail does not rest so securely on the sleepers, having no flat base like the *foot-rail*, or *bridge-rail*, but requires a chair on each sleeper. This greatly increases the expense in fastening to the sleepers.

Doub'le-head'ed Shot. (*Ordnance.*) A projectile formerly used, consisting of two shot united at their bases.

Doub'le-head'ed Wrench. One having a pair of jaws at each end, one diagonal the other right-angular. The shank of each outer jaw is connected to the sleeved inner jaw of the other pair, the sleeves slipping on the shanks of the jaws to which they are opposed. The double threads act in conjunction, to expand or close each pair simultaneously.

Fig. 1704.



Double-Headed Wrench.

Doub'le-hung Win'dow. One with two sashes, each having its complement of lines, weights, and pulleys.

Doub'le-im'age Mi-crom'e-ter. Suggested by Roemer about 1678; brought into use by Bonguer about 1748. It is formed by dividing diametrically the object-glass of a telescope or microscope, the straight edges being ground smooth so that they may easily slide by one another. The parts are separable by a screw, which moves an index on a graduated scale. A double image of the object in the field of view is produced by the separation of the segments; and by bringing the opposite edges of the two images into contact, a measure of the diameter of the object is obtained in terms of the extent of the separation. A *heliometer*.

Doub'le-im-pe'ri-al. A size of printing-paper 32 × 44 inches.

Doub'le-joint'ed Com'pass. One having, in addition to the main joint, additional joints by which legs may be bent to secure a proper presentation of the feet to the paper.

Fig. 1705.

Double-Jointed Compass.

Doub'le-knife. A knife having a pair of blades which may be set at any regulated distance from each other, so as to obtain thin

Fig. 1706.

Double-Knife.

sections of soft bodies. One form of this is known as Valentin's knife, from the inventor.

Doub'le-let'ter. (*Printing.*) Two letters on one shank, as *ff*, *ffi*.

Doub'le-light. A variety of light as displayed for the warning and instruction of mariners from lighthouses. The light indicates land, rock, or shoal, and, by varying the characteristics of the light, the seaman is informed of the part of the coast he is on, and of his bearings as to his port or course.

The other characters of light are known as *fixed*, *revolving*, *intermittent*, *flashing*, *colored*. These are variously combined.

The double-light is usually exhibited from two towers. One of these is sometimes higher than the other. The duplication of the lights affords a leading line as a guide to a channel, as well as furnishing another mode of varying the lights on a coast where they are numerous. See LIGHT.

Doub'le-line. (*Harness.*) *a.* A form of driving-lines or reins in which supplementary reins are afforded, which may be brought into use in emergency, such as an attempt to bolt. In some cases it is an extra rein to pull the horses' heads together; a rein to pull a hood over the eyes of a horse; a gag-rein to pull the bit violently into the corners of his mouth; a choking-rein around the throat; a gripper on the muzzle; shutters on the nostrils, etc.

b. A description of driving reins or lines in which each main branch has a check-line to the bit of the other horse. Distinguished from the Western teamster's *single-line*.

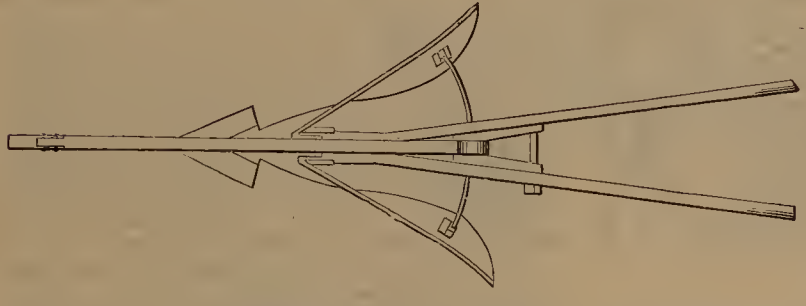
Doub'le-lock. A canal-lock having two parallel chambers connecting by a sluice. Each chamber has a gate at each end connecting with the upper and lower *pounds* respectively. The object is to save one half the water that would be used in *locking* boats.

Doub'le-mar'gin Door. (*Joinery.*) One framed in imitation of folding-doors, the central style being made double with an intervening bead.

Doub'le-me'di-um. A size of printing-paper 24 × 38 inches.

Doub'le-mold'board Plow. (*Agriculture.*) A plow having a moldboard on each side of the

Fig. 1707.



Double-Moldboard Plow.

sheth, so as to throw the soil away right and left. It is used in hilling up crops, such as potatoes and cabbages. Not used for corn; the rows are too wide apart.

A double-moldboard plow was used by the Romans in *ribbing* the ground for wheat. This left the ground in ridges whose summits were seeded by hand-drilling.

Doub'le Pi'ca. (*Printing.*) A size of type double the hight of Pica.

Double Pica.
Great Primer.
English.
Pica.
Small Pica.

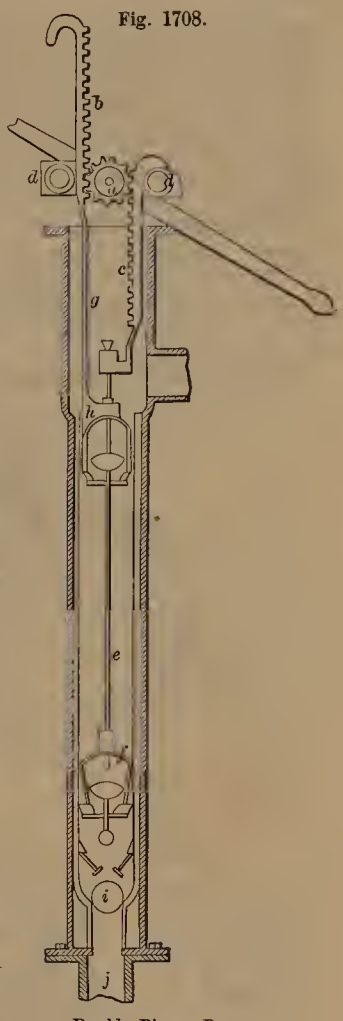
Doub'le-piled Fab'ric-loom. One in which a pile is formed on both sides of the *foundation*, and which may be produced from either the warp or weft. See Crompton's patent, January 31, 1871.

Doub'le-pis'ton Pump. One which works two pistons from a single lever or handle. It may be double or single acting as to the separate pistons.

In Fig. 1708 the pistons are effective alternately, each upon its up stroke. One bucket slides on the rod of the other. The lever gives reciprocating rotation to the pinion *a* which works the racks *b c*, which back against rollers *d d*; *g h* are the upper rod and bucket, *p* and *e f* the lower pair. *i* is the lower valve; *j* the induction-pipe.

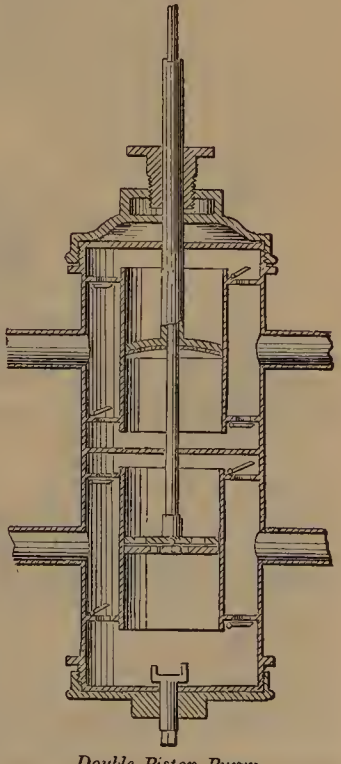
Another form is shown in Fig. 1709,

Fig. 1708.



Double-Piston Pump.

Fig. 1709.



Double-Piston Pump.

in which the pistons are fast on the same rod and reciprocate in their respective cylinders, which are divided by a diaphragm. The pumps are independent, therefore, except as the pipes may connect; and may be utilized for pumping fluids from two sources and delivering them together or separately.

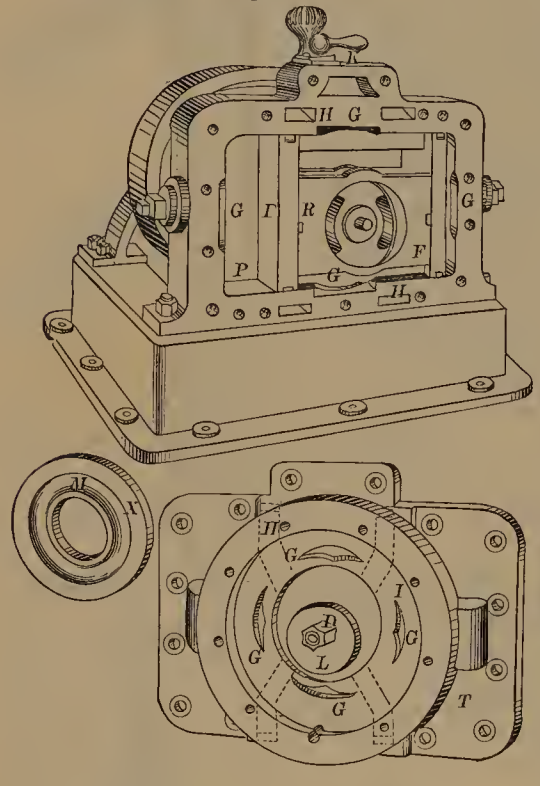
Doub'le Pis'ton-rod En'gine. A direct-action steam-engine invented by Maudslay and Field, London, and designed for

vessels of low draft and shallow holds, without exposing the machinery above deck. It is one of the numerous attempts to avoid the use of a beam or side-lever. See DIRECT-ACTION STEAM-ENGINE.

The *double piston-rod engine* has two piston-rods to each piston, the center of the cylinder-cover is plain, and this allows the crank when lowest to barely clear the said cover, thus saving the depth of a stuffing-box. The two piston-rods issue from opposite apertures, but neither in the longitudinal nor transverse line of the ship. It is said to afford the shallowest arrangement yet known with no beam above deck, and is used on the Rhone, the Indus, and the Sutledj.

Doub'le-pis'ton Square-en'gine. An engine having two square pistons at right angles to and one within the other. Fig. 1710 shows the arrangement; the larger or external is in the form of a rectangular frame, working horizontally within a box of similar form, and is marked *E*. The smaller, marked *F*, works vertically within *E*. Through the center of *F* passes the crank *D*, which is carried around by the simultaneous action of both pistons. The smaller piston *F* and crank *D* are shown separately. *T* is an outside view of the cover which closes the steam-box or cylinder, the circular chamber being the valve-box *I*, which is closed by another plate screwed over it. The steam is admitted at *K*, passes by a hidden passage to the valve-box *I*, and to the cylinder through openings *G*, whenever they are uncovered by the valve *X*. Through the same openings the exhaust-steam escapes, not into the valve-box, but into the annular channel *H* through the annular countersink *M*. The exhaust-steam escapes by passages indicated by dotted lines leading to the openings *H H*, and thence by passages to a common eduction-pipe. The valve-plate *X* is fitted to the eccentric *L* on the center-pin *D*, and this eccentric is carried around by a stud *S* in the end of the crank, which enters an arm on the other side of the plate, for which space is made in the central circular recess of the smaller piston. The valve is in contact by its circumference with the interior cylindrical surface of the valve-box, on which it rolls during its revolution, and it opens and closes the steam-ports successively as it passes.

Fig. 1710.

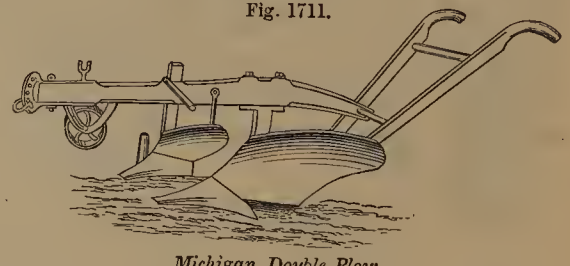


Root's Double-Piston Square-Engine.

Doub'le Plane-i'ron. (*Wood-working.*) A smoothing-plane iron having a *counter*-iron to bend up the shaving in working cross-grained stuff.

Doub'le-plow. 1. The double-plow, in which a shallow share preceded the deeper-running, longer plow, originated in England, where it is known as the *skim-colter plow*. This has a share attached to the colter to turn down the top soil with its weeds and trash, to be covered with the main furrow-slice, which is turned over by the larger plow following.

Fig. 1711.



Michigan Double-Plow.

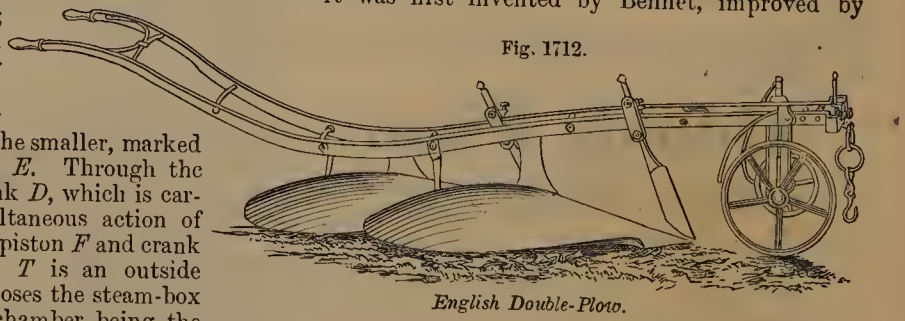
In England and in the United States another form of this plow has been used in which the precedent portion is not merely a flange on the colter, but is a regular moldboard plow of small proportions, higher than and in front of the main plow. This is known in Ohio as the "Michigan double-plow," and is an efficient implement requiring four horses.

2. The *double-plow*, having two plows to one stock, or two stocks framed together so as to have but one pair of handles and be operated by one man, is mentioned by Walter Blythe, who wrote during the protectorate of Oliver Cromwell. See GANG-PLOW.

Doub'ler. 1. (*Electricity.*) An instrument to increase the least conceivable quantity of electricity by continually doubling it, until it becomes perceptible upon a common electrometer or is made visible in sparks.

It was first invented by Bennet, improved by Darwin, and afterwards by Nicholson. See "Journal of the Telegraph," Vol. VI., No. 1, December 2, 1872.

Fig. 1712.



English Double-Plow.

2. (*Distilling.*) A part of the still apparatus, or an appendage to a still in which the low wines, one of the products of the first distillation, are re-distilled. The operation is a turning back and repeating, and is known as *doubling*. A part of the still is arranged to condense and then intercept and return the less volatile vapors, while those of greater tenuity pass on.

3. (*Fiber.*) A machine in which slivers, stricks, or filaments of wool, cotton, flax, or silk are laid together, to be drawn out and again doubled and drawn to remove inequalities, or, in the case of silk, to increase the thickness of the strand. See DOUBLING.

4. (*Calico-printing.*) A blanket or felt placed between the cloth to be printed and the printing-table or cylinder.

Doub'le-re-frac'tion Mi-crom'e-ter. The Abbé Rochon first applied the principle of double refraction to micrometrical measurements. His instrument had two prisms connected together so as to form a single crystal. The prisms are so disposed that the face of the first is perpendicular to the axis of the crystal, while in the second the axis is parallel to the line of intersection of the two faces, so that the axes of crystallization of the two prisms are at right angles to each other. The prisms are placed in perfect contact and cemented by mastic, and together form a plate, the opposite sides of which are parallel.

As the ray enters the second prism the ordinary ray passes on, and the extraordinary ray is refracted. The angle of divergence of the rays is constant in the same prism, and is determined by experiment.

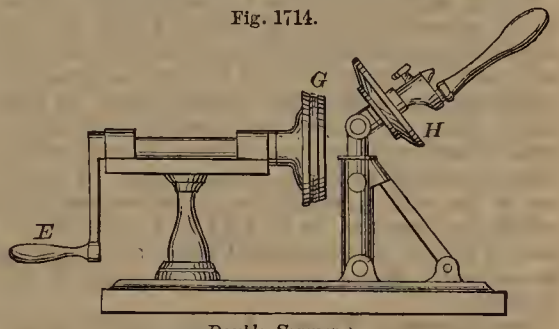
The apparatus is placed in the tube of a telescope, where it may be slipped back and forth. The determination of the diameter of the object is obtained by bringing the images in contact.

Doub'le-roy'al. A size of printing paper 26 × 40 inches.

Doub'le-saw. A stock having two blades at a regulated distance, adapted to cut kerfs and space the intervals, as in comb-cutting. See COMB.

Doub'le-seam'ing Ma-chine'. A tool or machine for lapping the edges of sheet-metal one over the other, and then doubling over the lapped portions so as to preclude the possibility of the portions slipping apart. The seaming process appears in Fig. 1713, where *a* represents a can top and lid simply laid together; *b* shows the two parts turned over; *c* shows the outer portion recurved over the inner one.

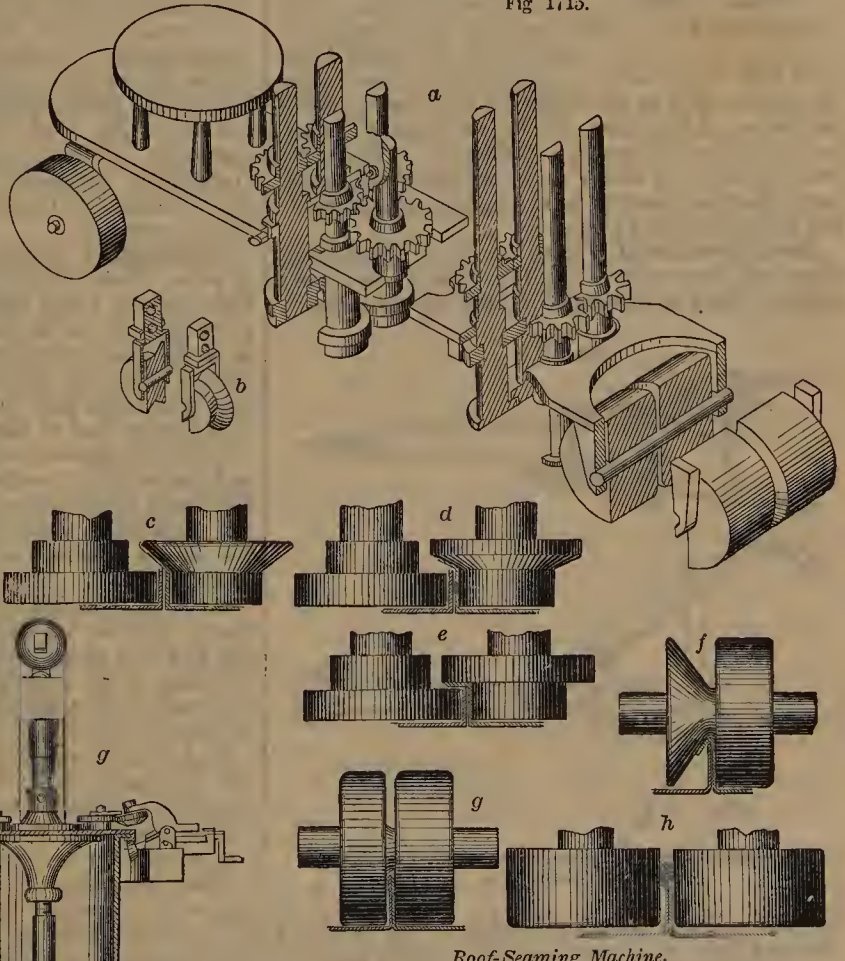
Fig. 1714.



Double-Seamer

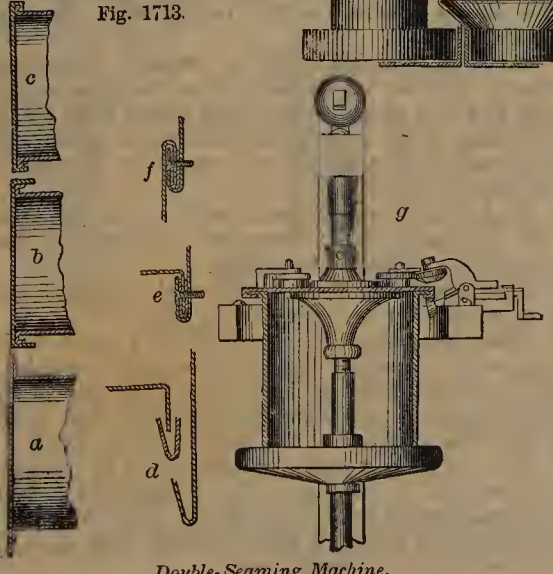
d, in the same figure, shows the parts of a seam

Fig 1715.



Roof-Seaming Machine.

Fig. 1713.



Double-Seaming Machine.

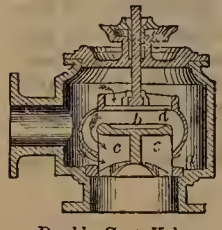
with an intervening strengthening strip; *e f* are two farther conditions of the same joint, with a rivet to secure the parts in position; *g* is a view of the machine on which the bending *a b c* is done by a succession of disks, cone-rollers, and clamping-rollers.

Fig. 1714 is another double-seaming machine in which the compressing disk *H* is journaled on top of the standard, and is brought into conjunction with the vertical disk *G* on which the pan or can rests, and is revolved by the crank *E*.

Double-seaming machines for roofing have a number of consecutive pairs of rollers which are run along the upturned edges of the adjacent sheets so as to lap one over the other, bend the two and press the folded-over part against the standing part. In Fig. 1715 *a* shows the machine in isometric projection, a series of transverse sections being made to show the different pairs of rollers in the succession. *b* shows one of the rollers detached and also sectioned to exhibit the structure. *c d e f g h* is a series of the pairs of rollers on an enlarged scale, and showing the successive shapes assumed by the edges of the tin plates.

Doub'le-seat Valve. Perhaps another name for the double-beat valve, and the more appropriate term of the two.

Fig. 1716.

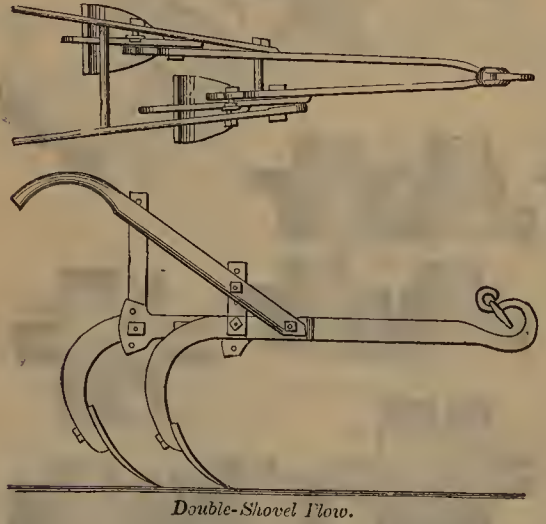


Double-Seat Valve.

The aperture *a* is beveled around to form the usual valve-seat. *c c* are two of five or six thin vertical plates radiating from the center and supporting the flat disk *b*, the edge of which is also beveled conically to form a second seat. The valve itself is a bulging cylinder *d*, open-ended, and shuts down upon both these seats. The effective pressure on the valve is only as the difference in the areas of the two seats. A bar across the top receives the valve-rod, which passes through a stuffing-box. The valve being opened, the steam enters at two ways, and a large effective opening is instantaneously afforded. See DOUBLE-BEAT VALVE.

Doub'le-shov'el Plow. A plow for tending crops, and having two small shovels on as many sheths. They are arranged a little distance apart,

Fig. 1717.

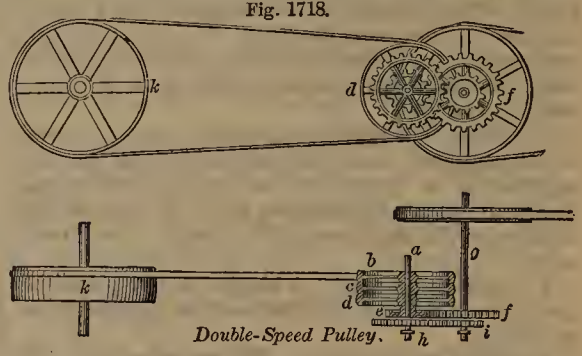


Double-Shovel Plow.

and one a little behind the other. The left-hand plow is a little in the rear when the right is specially engaged in working the crop.

Doub'le-speed Pul'ley. A contrivance for giving what is termed *double speed* to the spindles of the self-acting mule. On the spindle *a*, which receives the motion, are three drums, *b c d*; of these, *b* is fast on the spindle, *c* is loose, and *d* also loose, but connected with the pinion *e*, which works into the spur-wheel *f*, fixed on the spindle *g*, to

Fig. 1718.



Double-Speed Pulley.

which the motion is to be communicated. On the spindle *a* is fixed the spur-wheel *h*, which works into the pinion *i*, likewise fixed on the spindle *g*. When the belt from the driving drum *k* is on *b*, it communicates a fast motion to the spindle *g*; when on *c*, the machine is out of gear, and when on *d* it imparts a slow motion to *g*.

Doub'le Su'per-roy'al. A size of printing-paper 27 × 42 inches.

Doub'le Steam-en'gine. A steam-engine which has two cylinders acting coincidently or alternately. Two double-acting oscillating cylinders, acting upon a two-cranked shaft, work coincidently, and form a *double*-engine. Leopold's engine, about the middle of the last century, was a double-engine, a duplication of the Newcomen atmospheric-engine. It had two cylinders, each working its own pump, and operating alternately. The *double* steam-engine (Leopold's) preceded the double-acting (Watt's). See DOUBLE-CYLINDER STEAM-ENGINE; DUPLEX STEAM-ENGINE.

Doub'let. 1. (*Optics.*) An arrangement of lenses in pairs, invented by Wollaston. It consists of two plano-convex lenses having their focal lengths in the proportion of one to three, or nearly so, and placed at a distance determinable by experiment. Their curved sides are placed towards the eye, and the lens of shortest focal length towards the object.

It is a reversal of the Huyghenian eye-piece, and its object is similar, — to correct spherical aberration and chromatic dispersion. The *stop* placed between the lenses intercepts extreme rays that might mar the perfection of the image. An amplification of the idea is called a TRIPLET (which see). See also LENS.

Sir John Herschel's doublet consists of a double convex lens having the radii of curvature as one to six, and of a plano-concave lens whose focal length is to that of the convex lens as thirteen to five. It is intended for a simple microscope, to be used in the hand. See LENS.

2. A factitious gem made with a colorless front and a colored back, cemented together by clear mastic on the line of the girdle.

Doub'le-tang File. A file with a tang at each end, to adapt it to receive the handles.

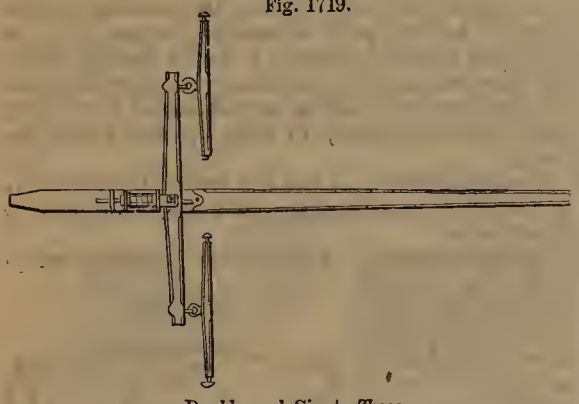
Doub'le-tree. The bar which is pivoted to the tongue of a carriage, wagon, or sled, or to the clevis of a plow or other implement. To the ends of the double-tree the single-trees are attached, and to the ends of the single-trees the traces are connected.

The double-tree varies in shape with the description of vehicle, but has such a length that its ends are immediately behind each horse, so that the traces of the animal may pull squarely upon them through the medium of the single-trees.

In wagons, the double-tree is attached to the tongue by means of a bolt called the *wagon-hammer*, upon which it swings as one or the other horse pulls the more strongly upon it.

Near the ends of the double-tree and behind it are loops for the *stay-chains*, which are connected to

Fig. 1719.



Double and Single Trees.

hooks in front of the fore-axle, so as to limit the sway of the double-tree.

For plowing and similar duty, the double-tree is sometimes arranged with three clevises; by the middle one it swings from the clevis of the plow or cultivator, and by the end clevises the *single-trees* are attached.

Dou'ble Wa'ter-wheel. An arrangement of two water-wheels on one shaft, as in the case of a double-headed turbine, which has a wheel at each end of a horizontal shaft.

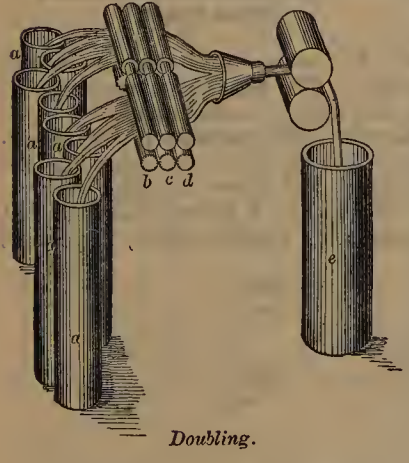
Dou'ble-win'dow. One having two sets of sash, inclosing a body of air as a non-conductor of heat and to deaden noise.

Doub'ling. 1. The second distillation of *low wines*. These are the product of the first distillation, and contain about one fifth alcohol.

2. The double course of shingles or slates at the eave of a house.

3. (*Cotton or Wool.*) Bringing two or more *slivers* of fiber together and forming them into one of greater thickness, to be again reduced by drawing; thus obtaining a sliver of uniform thickness.

Fig. 1720.



Doubling.

The slivers from the carding-machine, each in its separate can *a a*, are conducted between one pair of rollers *b*, which causes them to coalesce; then through a second pair *c*, revolving at an increased speed, which draws out and lengthens the sliver, and then through a third pair *d*, which still attenuates the sliver. The operation is repeated as often as may be necessary to correct every inequality in the thickness of the sliver.

The next process is *roving*, which is also performed by *drawing-rollers;* but as the sliver has become so reduced in thickness, it receives a slight twisting, to enable it to hold together. This was formerly obtained by giving a rapid revolution to the receiving-can *e*. See ROVING; DRAWING.

4. (*Flax-manufacture.*) The process with flax is similar to that described as pertaining to cotton.

In the first place, the *stricks* or handfuls of hackled flax are spread on a traveling-apron and conducted to drawing-rollers, which bring the filaments to an attenuated sliver and deliver it into cans. The slivers from a number of cans, from six to fifteen usually, are then conducted to drawing-rollers, being thereby *doubled* and *drawn;* the process is repeated, as with cotton, until the sliver is equalized and reduced to the required degree. See DRAWING.

5. (*Silk-manufacture.*) The twisting together of two or more filaments of twisted silk. This process follows the first spinning of the filaments of silk, and precedes the *throwing*, which is a farther combining of threads and twisting them together. First, the twisted filaments; then the *doubling*, forming *dumb-singles;* then the *throwing*, forming *thrown-singles*.

The process of doubling silk differs from that of doubling cotton and flax, inasmuch as the silk filaments are continuous and cannot be *drawn*. The *doubling* of flax or cotton fibers is for the purpose of equalizing the thickness of slivers, and the *drawing* which accompanies each operation is for the purpose of lengthening the combined slivers so as to make an attenuated sliver. By this means any trifling irregularity in the thickness of a sliver is lost by causing it to coalesce with others and elongating the bunch; the process being repeated again and again, as may be necessary.

In the doubling of silk, as there is no re-attenuation by drawing, the number of filaments are combined into one thread of the aggregate thickness of the several filaments.

The bobbins of thread to be doubled are mounted on a small frame, and the ends, being collected, are passed through a loop and attached to a bobbin, upon which they are wound. The parallel threads are then transferred to a horizontal reel, from whence each set of combined threads is carried through the eye of a rotating flyer and wound upon a bobbin, the combined threads or strands being twisted into a cord. The latter operation is known as *throwing*.

The direction of the twist is varied for different qualities and varieties of silk goods.

In ordinary spinning of the silk filaments the twist is to the right.

For *tram;* the spinning of the filaments is omitted; when *doubled*, the thread is twisted to the right.

For *organzine* the filament is twisted to the left, then *doubled* and twisted to the right.

The twisting of the thread is *set* or made permanent by exposure to steam.

6. (*Nautical.*) *a*. Of the bitts. A piece of fir timber fitted on the back of the cross-piece. *Fir-lining*.

b. Of a sail. The double-seamed border for receiving the bolt-rope. The edging or skirt.

7. (*Shipwrighting.*) Strakes of plank fastened on the outer skin of a ship; used as a fender against floating ice.

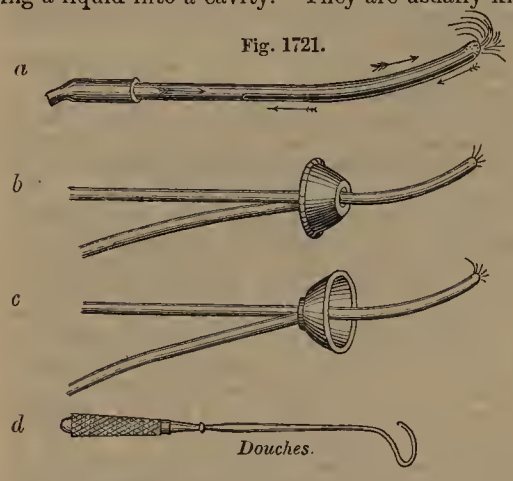
Doub'ling and Twist'ing Ma-chine'. One by which a number of slivers of fiber are associated, drawn out, and partially twisted; or one in which strands are laid together and twisted into a thread or cord. See DOUBLING; DRAWING-FRAME.

Doub'ling-frame. (*Silk-manufacture.*) A winding-engine for double silk threads.

Doub'ling-nail. A nail used in securing sheathing, lining, or supplementary covering to an object; such as the lining of gun-ports, etc.

Douche. (*Surgical.*) An instrument for injecting a liquid into a cavity. They are usually known

Fig. 1721.



Douches.

by the name of the part to which they are applicable.

a is a catheter douche for drenching the urethra, or reaching the interior of the bladder.

b is a douche for the vagina, having one tube for the water injected, and another for the efflux.

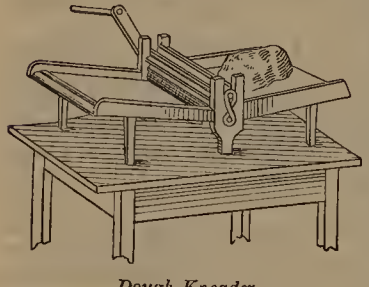
c is a uterine douche, with a cup to fit the cervix while the point enters the uterus.

d is a holder to be used with the vaginal or uterine douche.

Other douches are specially constructed for the nose, the posterior nares, the eye, ear, etc.

Dough-knead'er. A pair of rollers, one corrugated lengthwise and the other transversely, working in a frame with two inclined boards and a disk below the lower roller propelled by a crank, and the rollers geared together by elastic cross-bands. There are other forms, such as a roller swiveled to a post, like the brake of a cracker-maker, which is also a dough-kneader.

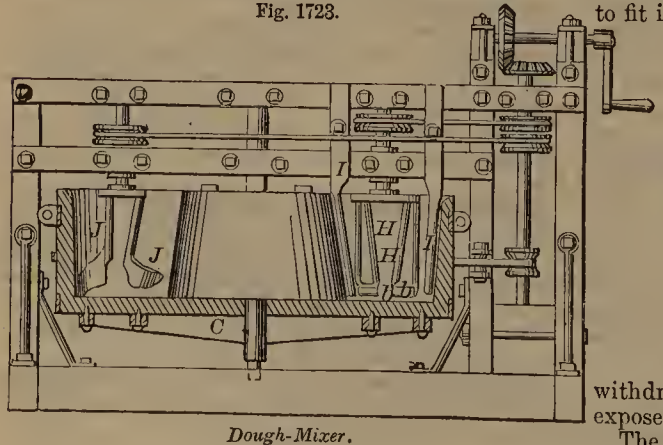
Fig. 1722.



Dough-Kneader.

Dough-mix'er. A kneading-machine consisting of a vessel having two pipes entering through its head and a discharge-pipe at the bottom. The flour is placed in the vessel, and the yeast and water, highly charged with carbonic acid and mixed with a proper quantity of salt, are passed into the vessel through one of the upper pipes, and the whole incorporated by the revolution of a vertical shaft with stirrers; when thoroughly mixed, the contents of the vessel are discharged through the pipe at the bottom. It is a kind of pug-mill.

Fig. 1723.



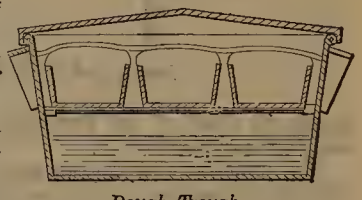
Dough-Mixer.

In another form of machine, the rotating annular trough *C* has two pairs of rotating beaters *H H*, to which are attached scrapers *b* for its bottom, while the sides are cleared by stationary scrapers *I*, and on the shafts are rods having screw-blades *J J*, reaching nearly to the bottom, to raise up and knead the dough.

Dough-rais'er. A pan in a bath of heated water, to maintain a temperature in the dough favorable to fermentation.

Dough-trough. A baker's or household receptacle, in which dough is left to ferment. In Fig. 1724 it consists of a water-tight, covered vessel of tin or other suitable material, with a perforated shelf across the center. The receptacles containing the dough are placed upon this perforated shelf, and then covered with a cloth to prevent the condensation of moisture upon the surface of the dough. Warm water is then poured into the lower part of the vessel, after which it is closed by means of a cover.

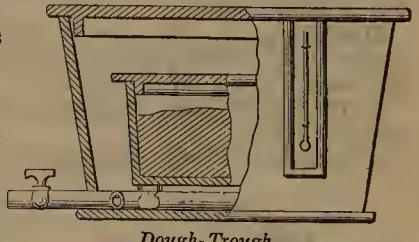
Fig. 1724.



Dough-Trough.

Fig. 1725 is on a larger scale, for the use of bakers, and consists of a box made with tapering sides and provided with a steam-pipe extending around the sides at the bottom. Inside of the box is the bread-chest, which is provided with feet, so as to elevate its bottom above the steam-pipe. The box is also provided with a thermometer, and with perforated plates.

Fig. 1725.

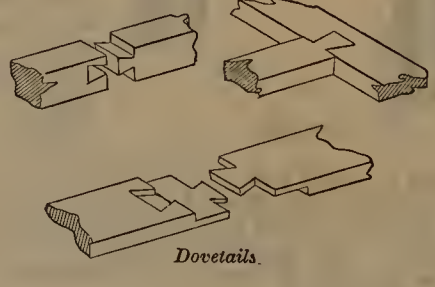


Dough-Trough.

Dous'ing-chock. (*Shipbuilding.*) One of several pieces fayed across the apron and lapped on the knighthead, or inside stuff above the upper deck.

Dove'tail. (*Joinery.*) A flaring tenon adapted to fit into a mortise with receding sides, to prevent withdrawal in the direction of the tension it will be exposed to in the structure.

Fig. 1726.



Dovetails.

The ancient Egyptians used dovetails of wood

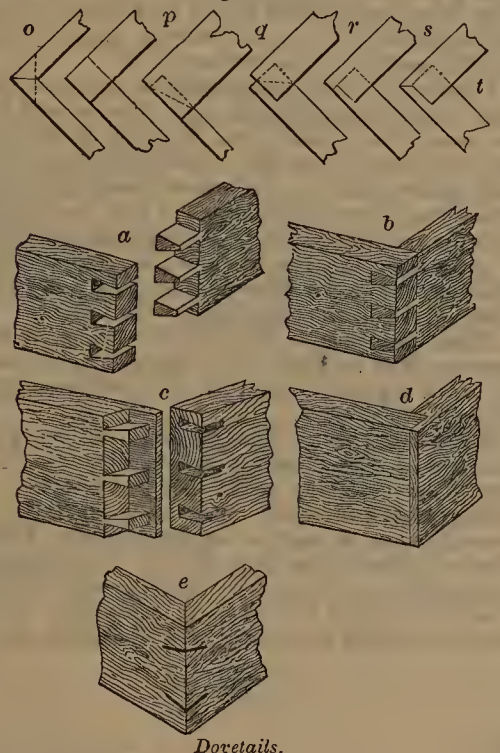
(*joggles*) to connect stones at the corners of their edifices.

a shows the ordinary dovetail with the parts detached ; *b* the parts put together.

Concealed dovetails are made in two ways : —

c d show the *lap-dovetail*, in which a fin of wood

Fig. 1727.



Dovetails.

on the return edge hides the ends of the tenons and mortises.

e shows a miter-joint, locked by oblique keys of veneer. The ordinary *miter-dovetail* shows only a single line on the edge.

The series of illustrations to Fig. 1727 show the several modes of dovetailing the edges of boxes and drawers.

o is a *miter and key* joint.
p, the common dovetail-joint.
q, the *half-lap* dovetail.
r, the *secret* dovetail.
s, the *lap*-dovetail.
t, the *miter*-dovetail.

Fig. 1728.

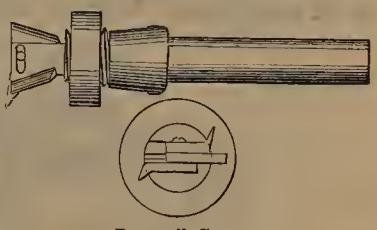
Dovetail Masonry.

Dovetailing of ashlar-work was occasionally adopted in olden times, but was first reduced to a regular system by Smeaton in the construction of the Eddystone lighthouses. The solid lines in the illustration show the 24th course of the mason-work.

Dove'tail-box Plane. (*Joinery.*) A form of rabbet-plane for dressing dovetails.

Dove'tail-cut'ter. A rotary cutter with a flaring bit used for boring dovetails.

Fig. 1729.



Dovetail-Cutter.

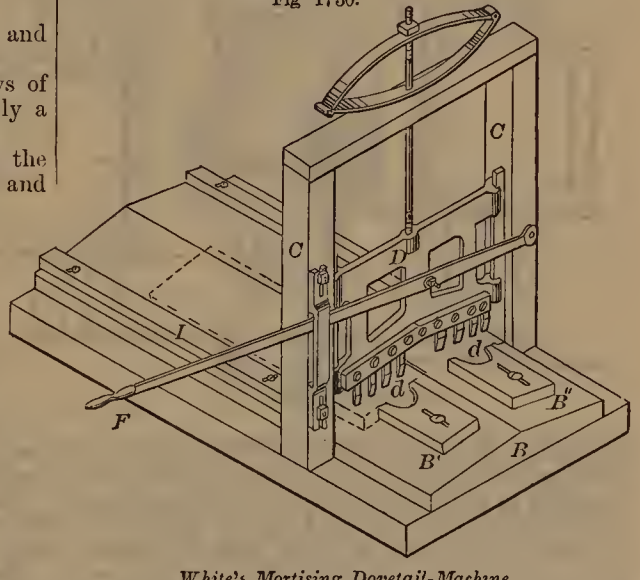
Dove'tail-file. A thin file with a tin or brass back, like the stiffener of a dovetail or tenon saw.

Dove'tail-hinge. A hinge whose leaves are wider at their outer edges than at their hinging edges.

A hinge whose attaching portions are branching and divergent, like a swallow's tail.

Dove'tail-ing-ma-chine'. A machine having a gang of chisels or saws for cutting dovetail-mortises or the kerfs therefor. In Fig. 1730, the horizontal base supports a block *B* whose upper surface consists of two equally but oppositely inclined planes *B' B''*, whose slope corresponds with the chamfer of the desired dovetails. *C C* are standards guiding to a vertical path a gate *D*, in which is fixed a series of chiscls whose cutting-ends are at such an unequal elevation as to correspond with the obliquity of the planes *B' B''*. These chisels are readily adjusted to any hight and degree of separation, and are fixed to their proper positions by screw-bolts.

Fig 1730.



White's Mortising Dovetail-Machine.

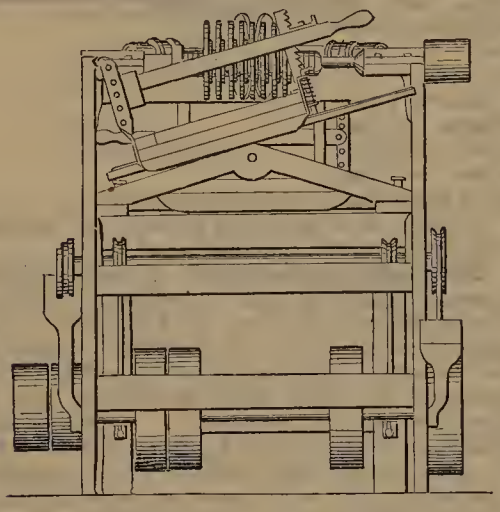
The gate is elevated and depressed by means of a lever *F*, and is gaged or arrested in its descent by a stop or shoulder. Stops on the planes *B' B''* gage the stuff. *I* is a gage for the edge of the stuff.

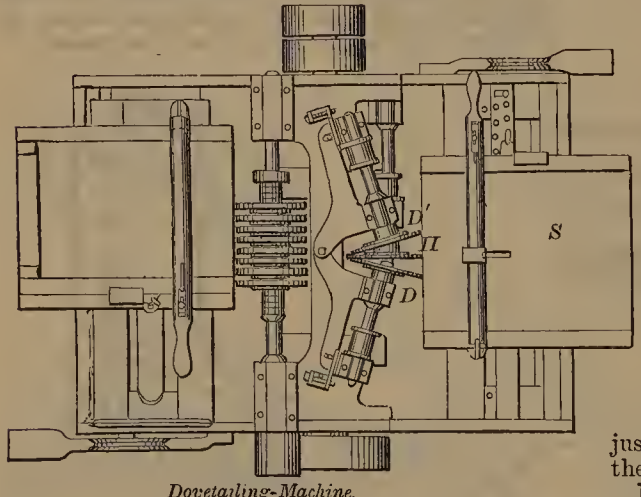
The board containing the heading-pins already sawed is placed on one of the inclines *B' B''*, and the chisels, being caused to descend, operate to excavate on one side the intervening stuff between the pins. The stuff being then placed on the other incline, and the gate again depressed, the excavation is completed by the cutting away of the opposite sides.

For excavating the mortises, the doubly inclined block *B* is removed, and another gate substituted for the gate *D*, in which substitute gate the chisels are so secured as to have their lower ends in a horizontal line. The stuff being placed on the horizontal bed and the chisels depressed, the surplus timber is excavated at a single stroke.

In Fig. 1731 is shown a machine in which the work is done by a gang of saws on a mandrel. The mortise-cutting portion is the right-hand part of the lower figure. In it the board is secured on

Fig. 1731.





Dovetailing-Machine.

the carriage *S*, in such position that the edge of said board projects under the saws or cutters more or less, according to the depth that the dovetailing is to be cut, which will be governed by the thickness of the stuff. The board, on being properly adjusted, is then brought in contact with the saws by elevating the table, thereby carrying the board upward to the saws *D D'*, cutting the sides of the mortise, and of any angle that may be required, by adjusting the stays in which the cutters are hung to the required angle.

The central cutter *H*, as will be seen, cuts into the board at a right line between the side saws, and as it leads in the cutting, the central portion of the mortise is cut away ; the side saws, as they follow, cut away the remainder, leaving a clean, angular mortise for the admission of the tenon.

The tenoning portion is on the other side of the lower figure, and is also shown in end elevation in the upper figure. The board is secured with its end projecting over the edge of the carriage, to which it is clamped ; the angle of the tenons being determined by the angle of the bed, as seen in the upper figure. The board and its bed are then raised to the cutters, one side of the tenons being cut at a time, together with a portion of the wood between them, which being done, the opposite side of the tenon is cut, and the remainder of the wood between them, by changing the position of the carriage.

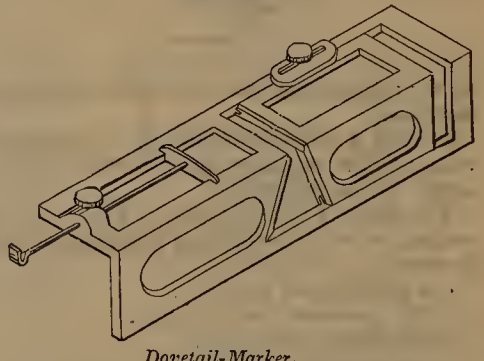
Armstrong's dovetailing-machine has two disks mounted on axes inclined to each other as well as to the main driving-shaft, one inclined to the right and the other to the left. Each disk has on its outer circumference a spiral groove, making one complete turn, into which is fitted a saw composed of segments, so arranged as in one complete revolution to give both the longitudinal and transverse cut necessary to finish a dovetail, one half being made by one disk and the other half by the other.

Other kinds operate by means of cutters, of form corresponding to that of the recesses to be made. The work is presented and fed on a table with the required adjustments.

Dove'tail-joint. The junction of two pieces by means of splayed tenons and corresponding mortises of the respective parts. See DOVETAIL.

Dove'tail-mark'er. A device for marking the dovetail tenons or mortises on the respective boards. The two plates of the frame are set at right angles to each other, and each has a scribing edge adapted to mark its side of the dovetail ; one plate is adjustable to regulate the widths and distances, the adjustable gage-plate affording a guide in setting the marker for the next scribe.

Fig. 1732.



Dovetail-Marker.

Dove'tail-plane. (*Joinery.*) A side-rabbet plane with a very narrow sole, which may be made by inclination to dress the sides of dovetail tenons or mortises.

The side-rabbet plane may have an under-cutting bit with a flat lower edge, so as to conform to the shape of the mortise.

Dove'tail-saw. 1. One for cutting the dovetail-tenon on the ends of boards ; or cutting the dovetail-mortises in the faces or ends of boards to receive the said tenons. There are several varieties. One consists of a pair of circular saws running in planes, bearing such angular relation to each other as to give the required obliquity to the kerfs. In dovetailing-machines rotary cutters work to a given line, and also remove the material between the cheeks of opposite dovetail-tenons. Gangs of circular saws on a mandrel are constructed and arranged to do the same. (See Fig. 1731.)

2. A small tenon-saw adapted for cutting dove-

tails. It has 15 teeth to the inch, and is usually about 9 inches in length.

3. A saw having two cutting edges, one at right

Fig. 1733.

Dovetail-Saw.

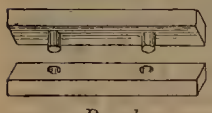
angles to the other; one edge makes the side kerf, the other the bottom kerf.

Dove'tail-wire. A kind of wire, wedge-shaped in cross-section.

Dow. A two-masted Arabian vessel. See DHOW.

Dow'el. 1. A pin used to connect adjacent pieces, penetrating a part of its length into each piece at right angles to the plane of junction. It may be permanent and glued into each piece, as in the boards forming the *leaf* of a table. Or it may serve as a joint to hold detachable pieces in position, as the *parts* of a *flask*.

Fig. 1734.



Dowel.

The slabs of calcareous gypsum or "Mosul marble" which line the adobe palaces of Nimroud were united by wooden and bronze *dowel-pins*. The several blocks in each layer of masonry in Smeaton's Eddystone lighthouse were *cramped* together, and the layers were prevented from slipping on each other by oaken *dowels*.

2. A piece of wood driven into a wall, as a means of nailing lining or finishing work thereto. A *dook*.

Dow'el-bit. A wood boring-tool adapted to be used in a brace. The semi-cylinder which constitutes the *barrel* of the bit terminates in a conoidal cutting-edge. It is also called a *spoon-bit*. See BIT.

Dow'el-ing-ma-chine'. (*Coopering.*) A machine for boring the dowel-holes in the meeting edges of the pieces which form the heads of tight casks.

Dow'el-joint. A junction formed by means of a dowel pin or pins, such as the heading pieces of a tight barrel-head.

Dow'el-pin. A pin or peg uniting two portions, as the pieces of heading for a cask. A *dowel*.

Dow'las. (*Fabric.*) Probably named from Doullens, a town of Picardy in France. A coarse linen cloth for household uses.

"Filthy dowlas," says the Bard of Avon.

Down-cast. (*Mining.*) The ventilating-shaft of a mine, down which air passes to the workings; as opposed to the *up-cast*.

Down-haul. (*Nautical.*) A rope for hauling down a staysail, jib, or other fore-and-aft sail. With staysails it passes along the stay through the cringles of the sail, and is attached to the upper corner.

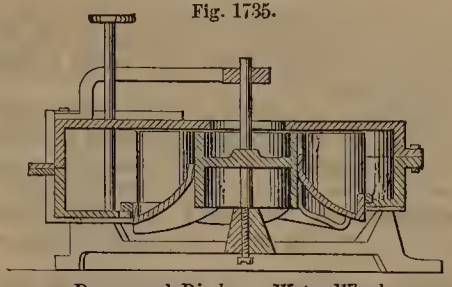
Down-share. A turf-paring plow, used in England, where the rolling treeless tracts are called *downs*. These tracts in Sussex are the homes of the Southdown sheep. (A. S. *Dun*, *dune*, a hill.) The sand-banks which lie upon the sea-shores of Holland are called *dunes;* hence Dunchurch in England, Dunkirk in the Low Countries. Hence also the Downs, the famous anchorage off the coast of Kent, England, where the Goodwin Sands form a breakwater: —

"For whilst our pinnace anchors in the Downes."
2 HENRY VI., iv. 1.

Dows'ing-chock. See DOUSING-CHOCK.

Down'ward-dis'charge Wa'ter-wheel. One form of the turbine or reaction water-wheel. The water is admitted at the periphery, from a spiral chute

Fig. 1735.



Downward-Discharge Water-Wheel.

which surrounds the wheel, and, passing inward in a radial direction, curves and descends vertically.

Drab. 1. (*Fabric.*) A thick woolen cloth of a dun color, inclining to reddish-brown.

2. A wooden box used in salt-works for holding the salt taken from the boiling-pans.

Drab'bets. (*Fabric.*) A coarse linen duck.

Drab'ler. (*Nautical.*) A piece of canvas laced on the bonnet of a sail, being an extension of the bonnet, as the latter is of the sail proper.

Dradge. The inferior portions of ore detached from other portions by the *cobbing*-hammer. The better parts are known as *prill*.

Draft. 1. The current of air which supplies a fire. When this is not mechanically aided, it is called a *natural* draft. When driven mechanically, it becomes a *forced* draft or *blast*. See BELLOWS; BLAST; BLOWING-MACHINE; FAN, etc.

It is also known as *cold* or *hot* blast, according to the temperature; that of the external atmosphere, or artificially heated.

2. (*Steam-boiler.*) The course or direction of the hot air and smoke; as, —

A *direct*, a *reverting*, a *split*, or a *wheel draft*.

3. A plan or delineation.

4. The drawing or pulling of a load or vehicle. In this connection the word forms a part of many compound words; as, —

Draft-bar.	Draft-rod.
Draft-hole.	Draft-spring, etc.

See also DRAW; DRAG.

5. (*Masonry.*) Chisel-dressing at the angles of stones, serving as a guide for the leveling of the surfaces.

6. (*Pattern-making.*) The amount of taper given to a pattern to enable it to be withdrawn from the mold, without disturbing the loam.

7. The depth a ship sinks in the water.

8. The combined sectional area of the openings in a turbine water-wheel; or the area of opening of the sluice-gate of a fore-bay.

9. (*Weaving.*) The arrangement of the heddles so as to move the warp for the formation of the kind of ornamental figure to be exhibited by the fabric. Known also as *drawing*, *reeding-in*, *cording of the loom*.

In every species of weaving, whether direct or cross, the whole difference of pattern or effect is produced, either by the succession in which the threads of warp are introduced into the *heddles*, or by the succession in which those *heddles* are moved in the working. The *heddles* being stretched between two shafts of wood, all the *heddles* connected by the same shafts are called a *leaf;* and as the operation of introducing the warp into any number of leaves is called *drawing a warp*, the plan of succession is called a draft.

Draft-bar. 1. A swingle-tree, double or single.

2. The bar of a railway-car with which the coupling is immediately connected.

Draft-box. Invented by Parker. An air-tight

tube by which the water from an elevated wheel is conducted to the tail-race. It is a means of availing the whole fall without placing the wheel at the bottom of the same.

It is sometimes used to avoid extreme length of wheel-shaft; at other times to conform the arrangements to the peculiar location, rendering it necessary to place the wheel at a distance above tail-water.

Draft-en'gine. (*Mining.*) An engine (usually steam) for elevating ore, coal, miners, etc., or for pumping out water.

Draft-e'qual-iz'er. A treble tree; a mode of arranging the whiffletrees when three horses are pulling abreast, so that all possess an equal leverage.

Draft-fur'nace. A reverberatory air-furnace; one in which a blast is employed.

Draft-hole. The hole whereby a furnace is supplied with air.

Draft-hook. One of the hooks on the checks of a gun-carriage to maneuver it, or attach additional draft-gear in steep places.

Draft'ing In'stru-ments and Ap-pli'ances.

Arcograph.
Bow-pen.
Bow-pencil.
Camera (*Obscura* and *Lucida*).
Cecograph.
Centrolinead.
Chiragon.
Compasses (varieties, see COMPASS).
Copying-instrument.
Crayon.
Curve.
Curvilinear.
Curvograph.
Cyclograph.
Diagonal scale.
Dividers.
Dotting-pen.
Double drawing-pen.
Double-jointed compass.
Drafting-board.
Drafting-scale.
Drawing-compass.
Drawing-pen.
Drawing-pin.
Eidograph.
Elevation.
Ellipsograph.
Everpoint-pencil.
Fountain-pen.
Froude's compass.
Geometric pen.
Gold pen.
Hair-pencil.
Helicograph.
Ink-well.
Isometrical projection.
Lead-pencil.
Leg.
Lengthening-pen.
Manifold-writer.
Map-measurer.
Micrograph.
Music-pen.
Music writing-machine.
Napier's compass.
Needle-holder.
Optigraph.
Palette.
Pantograph.
Parallel ruler.
Pastel.
Pen.
Pencil.
Pencil-case.
Pencil-sharpener.
Pen-holder.
Pen-knife.
Pen-maker.
Pen-rack.
Perspective instrument.
Perspectograph.
Pillar-compass.
Plan.
Planimeter.
Plotting-scale.
Polygraph.
Port-crayon.
Profile.
Proportional compasses.
Protracting-bevel.
Protractor.
Quill-pen.
Reticulation.
Right-line pen.
Roulette.
Rule.
Ruler.
Ruling-pen.
Scale. Drafting
Sciograph.
Scorer.
Scotograph.
Section.
Sector.
Silhouette instrument.
Slate.
Slate-pencil.
Sliding-rule.
Spirals. Instrument for drawing
Square.
Station-pointer.
Steel-pen.
Straight-edge.
Tablet.
Tangent-scale.
Tracing-instrument.
Trammel.
Triangle.
Triangular compass.
T-square.
Tube-compass.
Universal-compass.
Vertical plan.
Whole-and-half compass.

Draft'ing-scale. A straight edge graduated with scales of chains and tenths, or inches and twelfths, for platting surveys, or drafting plans or elevations of machinery or other structures.

Draft-reg'u-la'tor. A means for opening and closing furnace-doors, or dampers in the air, draft, or discharge flue, so as to urge the fire or moderate its intensity respectively, as it may lag below or quicken above the desired standard.

Automatic devices for this purpose are actuated by arrangements known as *thermostats*. These usually depend upon the expansion of metal by heat and its consequent contraction as it cools. The lengthening or shortening of a metallic rod is the actuating force which is communicated by levers or other mechanism to the door, register, or damper. As a certain relation exists — under ordinary conditions — between the heat of steam and its pressure, the heat or pressure of steam acting on a column of mercury may be made by electric connection to actuate a magnet, and so operate the device which governs access of air to the furnace, or determines the area of the flue by which the volatile results of combustion are discharged. See DAMPER.

Draft-rod. (*Plow.*) A rod extending beneath the beam from the *clevis* to the *shcth* and taking the strain off the *beam*.

Draft-spring. A spring intervening between the tug or trace of a draft animal and the load, whereby a jerking strain upon the animal is avoided. It was invented and used by Sir Alexander Gordon. Draft-springs are connected to the draw-bars of railway cars, to lessen the violence of the jerk in starting.

Drag. 1. (*Husbandry.*) A heavy description of harrow.

2. (*Nautical.*) A floating anchor, usually a frame of spars and sails, to keep a ship's head to the wind and lessen the speed of drifting. See DRAG-ANCHOR.

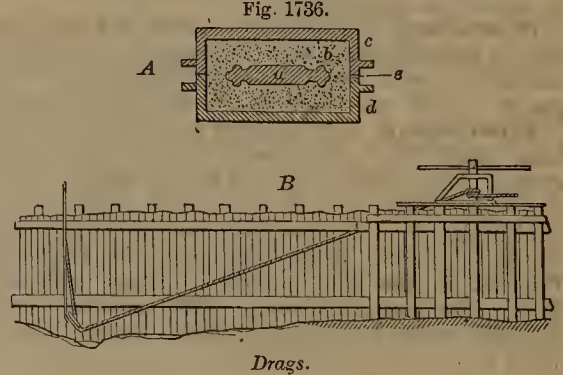
3. (*Vehicle.*) *a.* A shoe to receive the wheel of a vehicle to stop its revolution, and by friction on the ground lessen the speed of the vehicle down hill. See WAGON-LOCK.

b. A rough, heavy sled for hauling stones off a field, or to a foundation. A stone-boat.

c. A kind of four-horse vehicle used by sporting characters.

4. (*Molding.*) *A*, the bottom part of a mold, as distinguished from the cope.

Fig. 1736.



Drags.

a, object cast.
b, loam.
c, cope.
d, drag.
e, parting.

5. (*Hydraulic Engineering.*) *B*, a scoop having a long flexible handle and operated by a winch, for

deepening a channel, scraping a place for a submerged foundation, or removing the mud, etc., from the inside of a coffer-dam. A form of dredging-machine.

6. (*Sawing.*) The carriage on which a log is dogged in a veneer saw-mill. The drag has two motions, one past the saw to yield a veneer, and the other at right angles to the same and equal to the thickness of the veneer, plus the width of the kerf. See VENEER-SAW.

7. A net or four-clawed grapnel used in *dragging* a pond or harbor to recover the body of a drowned person, or property which has been lost overboard. A *creeper*.

8. (*Masonry.*) A thin, indented plate for scraping and finishing the surface of soft stone.

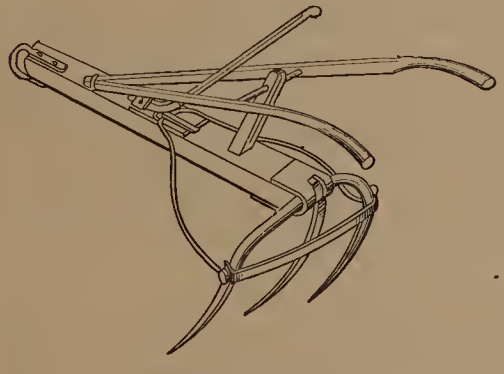
9. (*Marine Engineering.*) The difference between the speed of a screw-ship under sail, and that of the screw when the ship outruns the latter. See SLIP.

The difference between the propulsive effects of the different floats of a paddle-wheel.

10. A frame of iron with an attached net to scrape up and gather oysters by *dragging* upon the bed. See DREDGE.

11. (*Husbandry.*) An implement with hooking

Fig. 1737.



Manure-Drag.

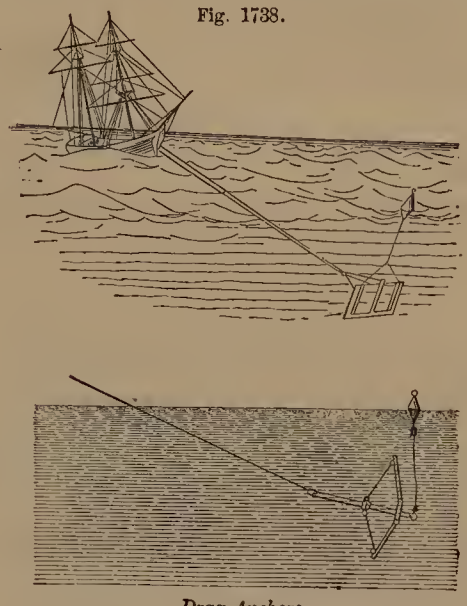
tines to haul manure along the surface. A manure-drag.

Drag-an'chor. (*Nautical.*) A frame of wood, or of spars clothed with sails, attached to a hawser, and thrown overboard to drag in the water and diminish the lee-way of a vessel when drifting, or to keep the head of a ship to the wind when unmanageable by loss of sails or rudder. It was patented under the name of a *drag-sheet*, by Burnet (English) 1826. It is sometimes made, in an emergency, of spars lashed together to form a triangular or rectangular frame, which is then covered with a sail. When constructed and carried as a part of the ship's equipment, it is made to serve as a raft or drag as may be required; but the peculiarities are generally confined to means for compact stowage and to spilling-lines for their recovery, either by collapse or reversal of position to enable them to be readily drawn in and hauled on board after having served their purpose. Treatises on navigation give illustrations of a variety of devices for this purpose, and a number are patented. One edge of the drag may be weighted, as it is essential that it be submerged, and that it should assume a position at right angles to the taut cable which connects it to the ship.

In the upper view (Fig. 1738), the drag is a wooden frame whose corners are secured by bridles or angle-lines to a cable which is made fast to the bitts on board. A buoy is attached to the upper edge of the drag, and a spilling-line enables the drag to be canted over, so as to diminish its resistance when being drawn in.

In the lower view the ribs of the wings are hinged to a hub on the shaft, so that they may expand when

Fig. 1738.



Drag-Anchors.

brought into use and may contract when the drag is upset by the spilling-line while it is being drawn in. A buoy is used, as in the drag described above, to show the position, and to keep the drag in its effective position. Braces connect the ribs to a sliding collar on the shaft, and the frame is covered like an umbrella with heavy sail-cloth lashed to the ribs.

Drag-bar. (*Railway-engineering.*) A strong iron rod with eye-holes at each end, connecting a locomotive-engine and tender by means of the drag-bolt and spring.

Drag-bench. A bench on which fillets of gold or silver are drawn through an aperture, to bring them to even and exact proportions. See DRAW-BENCH.

Drag-bolt. The strong removable bolt coupling the drag-bar of a locomotive-engine and tender together.

Drag-hook. The *drag-hook and chain* are the strong chain and hook attached to the front of the engine buffer-bar, to connect it with any other locomotive-engine or tender; also attached to the drag-bars of other railroad carriages on the English system of connection.

Drag-link. A link for connecting the cranks of two shafts; it is used in marine engines for connecting the crank on the main-shaft to that on the inner paddle-shaft.

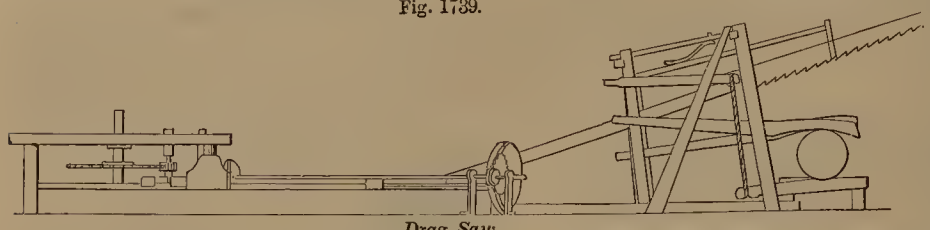
Drag'on-beam. (Corrupted from *diagonal* beam.) (*Building.*) *a.* A horizontal timber or diagonal plate used in hipped roofs and on which the foot of the hip-rafter rests. *Dragging-beam.*

b. A diagonal brace which stands under a breast-summer and whose foot rests on a shoulder of the king-post.

Drag-saw. A cross-cut sawing-machine in which the effective stroke is on the pull motion, not the thrust. In the illustration it is shown as operated by horse-power. The log is clamped by levers. The saw is held aloft by a stirrup while the log is fed forward for another cut.

Drag-sheet. (*Nautical.*) A sail stretched by spars and thrown over to windward to drag in the

Fig. 1739.



Drag-Saw.

water and lessen the lee-way of a drifting vessel. See DRAG-ANCHOR.

Drag-spring. (*Railroad.*) *a.* A spring attached to the *drag-bar* to lessen the jerk when starting up or increasing speed.

b. A strong spring placed near the back of the tender. It is attached by the ends to the drag-bar which connects the engine and tender, and by the center to the drag-bar which connects the train to the tender, according to the English mode.

Drag-staff. (*Vehicle.*) A pole pivoted to the hind axle and trailing behind a wagon or cart in ascending a hill or slope. Used to hold the vehicle from rolling backward when temporarily stopping on a hill to rest the team.

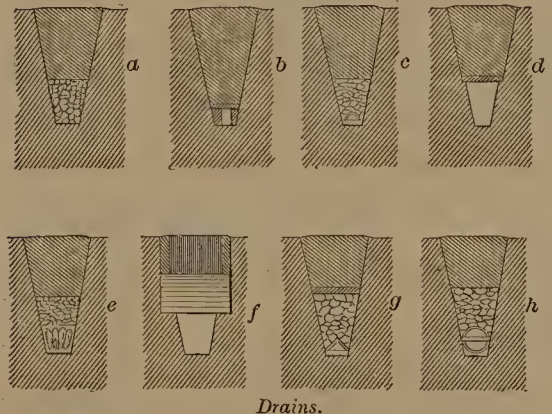
Drain. 1. A water-course to remove surface water, or so much from the subsoil as interferes with the fertility of that above it.

Covered drains are made in a variety of ways : —

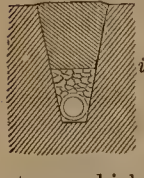
a. A layer of stones in the bed, covered by the earth which had been removed in digging.

b. Where flat stone is obtainable, two side stones and a cap, covered in with the soil.

Fig. 1740.



Drains.



c. A duct formed with a flat tile and an arched semicylindrical tile, covered in with stones, to allow percolation of water, and closed with soil.

d. In tenacious soils a shoulder may be made in the drain to support flat stones which bear the superincumbent earth.

e. Assorted, large stones in the bottom, covered in by smaller stones and a filling of soil.

f. In peaty soils the drain may be covered in with blocks of the peat or by turfs which will preserve their position for a considerable time if laid properly.

g. A bed stone and side stones to form a triangular duct covered in by stones, a layer of turf, and the filling of soil.

h. A duct formed of two semicylindrical tiles, respectively above and below a flat tile ; the whole covered in by stones and the earth as before.

i. A perforated drain-pipe of circular or oval section covered in by stones and earth.

In the fen lands of Cambridgeshire, England, and other lands of the same description in adjoining counties, the main drains have generally been made 7½ feet deep, or more in larger districts, so that the water may never rise higher than within 18 inches or 2 feet of the surface of the ground. The ladles or float-boards of the scoop-wheel dip 5 feet below the surface of the water, leaving a foot in depth below the dip of the wheel, that the water may run freely to it. The main drain brings down the water to the engine with a descent of 3 inches in a mile ; 5 to 18 inches is better. Supposing that the wheel dips 5 feet below the surface of the water in the main drain, and that the water in the river into which this water must be raised and discharged has its level 5 feet above that in the drain, the wheel in such case will be said to have 10 feet head and dip, and ought to be made 30 feet in diameter.

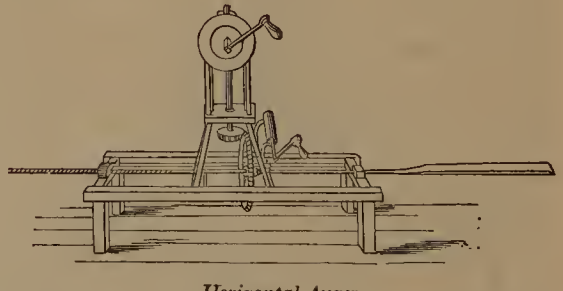
The largest quantity of water delivered by one engine is from Deeping Fen, near Spalding ; this fen contains 25,000 acres, and is drained by two engines, one of 80 and one of 60 horse power. The 80-horse engine has a wheel of 28 feet in diameter, with float-boards or ladles measuring 5½ feet by 5 feet, and moving with a mean velocity of 6 feet per second ; so that the section of the stream is 27½ feet, and the quantity discharged per second 165 cubic feet,— equal to more than 4½ tons of water in a second, or about 16,200 tons of water in an hour.

It was in 1825 that these two engines were erected, and at that time the district was kept in a half-cultivated state by the help of forty-four windmills, the land at times being wholly under water. It now grows excellent wheat, producing from 32 to 48 bushels to the acre. The land has increased in value fourfold. See SCOOP-WHEEL.

2. (*Founding.*) The trench which conducts the molten metal to the gate of the mold.

Drain'ing-au'ger. A horizontal auger occasionally used for boring through a bank to form a chan-

Fig. 1741.



Horizontal Auger.

nel for water. It is also used for cutting an opening for laying lead-pipe or drain-pipe. In each case it is intended to save the labor of opening a trench. It is also used for draining marl-pits or cellars, when the circumstances of the level suit.

The mode of operation is as follows : the level having been determined, a spot is leveled on the down-hill side for placing the machine. The horizontal axis above is turned by two men at the hand-

cranks, rotating the vertical shaft and bevel pinion which turns the larger wheel on the shaft of the auger.

When the pod of the auger is full, it is withdrawn by rotating the other handle. If hard stones be encountered, the auger is withdrawn and a chisel or drill substituted.

Drain'ing-en'gine. A pumping-engine for removing water from mines, lowlands, etc. See CORNISH ENGINE.

The *scoop-wheel* and the *baling-scoop* are much used in England. The *centrifugal pump* is used in England and the United States. The pumping-engines used in Holland at the Haarlem Mere are vertical double-cylinder condensing-engines, one cylinder within the other, the outer one being annular.

All other drainage enterprises sink into insignificance beside those of Holland.

These great public works, since their commencement in 1440, have gradually extended until they include an area of 223,062 acres drained by mechanical means. See Weale's "Dictionary of Terms of Art," pp. 277 – 283.

One of the latest, and the largest, of these enterprises, was the drainage of the Haarlem Lake, 45,230 acres, which was finished a few years since.

The average level of the boezem, or catch-water basin, of the district is 10 inches below the ordinary low-water, and 27 inches below high-water mark in the Y or Zuyder Zee; and 7 inches above low water, and 57 inches below ordinary high water, in the North Sea.

The bed of the Haarlem Lake is 14 feet below the winter level of the boezem, and the maximum lift may be therefore assumed to be 27 inches + 14 feet + 18 inches, — the last being the required depth of the water surface below the ground surface, to render the latter tillable, — amounting in all to 17 feet 9 inches.

The water contents of the Haarlem Mere to be pumped out, including the additional quantity arising from the surplus rain and infiltration during the draining, was estimated at 800,000,000 tons.

The greatest quantity of monthly drainage when the mere is pumped out is estimated at 36,000,000 tons, and the annual average surplus of rain-water, etc., at 54,000,000 tons, to be lifted, on an average, 16 feet.

The three engines were named the "Leeghwater," erected about 1847, the "Cruquius," and the "Lynden," after three celebrated men who had at different periods proposed plans for draining the Haarlem Mere.

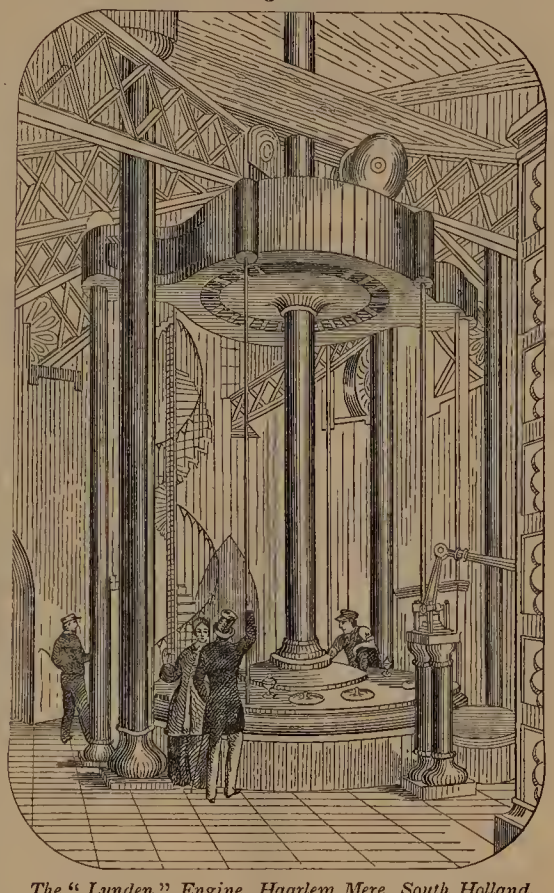
The "Leeghwater" was the first erected, to work eleven pumps of 63 inches diameter, with 10 feet stroke in pumps and steam-cylinders; and the "Cruquius" and "Lynden" were afterwards constructed, to work eight pumps each, of 73 inches diameter and with 10 feet stroke; each engine is calculated to lift 66 tons of water per stroke.

In testing the capacity of the engine for working in emergencies, using the eleven pumps simultaneously without regard to the consumption of fuel, the engine was found to lift per stroke 109 tons net of water to a hight of 10 feet. At an economical working-rate the engine performed a *duty* of 75,000,000 pounds, raised one foot high by a consumption of 94 pounds of Welch coal. The net effective force was 350-horse power, the consumption of fuel 2¼ pounds of coal per horse-power per hour.

The accompanying sketch is a representation of the interior of the "Lynden" engine and engine-house, on the upper floor; the "Cruquius" is on the same model; but the "Leeghwater" has the inner ends of its eleven pump-beams arranged under the great cross-head, instead of over it.

Each engine has two steam-cylinders, placed concentrically, the one within the other, the outer of 12 feet diameter, and the inner one of 7 feet diameter; both are secured to one bottom, and covered by one cover, but the inner cylinder does not touch the cover within 1½ inch; there are two pistons, 26 inches deep, the compartments of which are fitted with cast-iron plates; the outer piston is annular, and has a packing on both sides; beneath this annular piston a constant vacuum is maintained when working; the two pistons are connected by five piston-rods, as shown in the sketch, to a great cross-head or cap, the whole mass weighing about 85 tons, and by eight connecting-rods the cap-pistons

Fig. 1742.



The "Lynden" Engine, Haarlem Mere, South Holland.

are suspended from the inner ends of eight cast-iron balance-beams, to the outer ends of which are hung the eight pump-pistons.

The action of the engines is very simple; the steam, being applied under the inner piston, lifts both the pistons, the great cross-head, and inner ends of pump balance-beams simultaneously, and the pump-pistons descend at the same time; by an hydraulic apparatus attached to the great cross-head, the dead weight of the pistons, etc., is arrested at the point to which it has been thrown up by the steam, and time is given for the valves of the pump-pistons to close before the down-stroke of the steam-pistons is made; then, the equilibrium-valve being opened, the hydraulic apparatus is liberated at the same moment, and the steam passing from beneath the small piston above both pistons, the pressure on both sides of the small one is equalized, while nearly two thirds of the steam acts upon

the annular piston against a vacuum, and in aid of the dead weight helps to make the down-stroke in the steam-cylinder and the up-stroke in the pumps. The use of the two cylinders enables the engineman, by judiciously altering the expansion in the small cylinder, to command his work at all times, without stopping the engine to take out or put in dead weight, as would be necessary for a single-acting one-cylinder engine, where dead weight only is used for lifting the water. It has frequently occurred that the load of an engine has been added to or diminished by ten or twelve tons in the course of half an hour, by the action of gales of wind on the surface of the mere and boezem. Each engine has two air-pumps of 40 inches diameter, and 5 feet stroke. The steam is cut off in the small cylinder at from one fourth to two thirds of the stroke, according to the load; and after expanding through the remainder of the stroke, it is still farther expanded in the large cylinder.

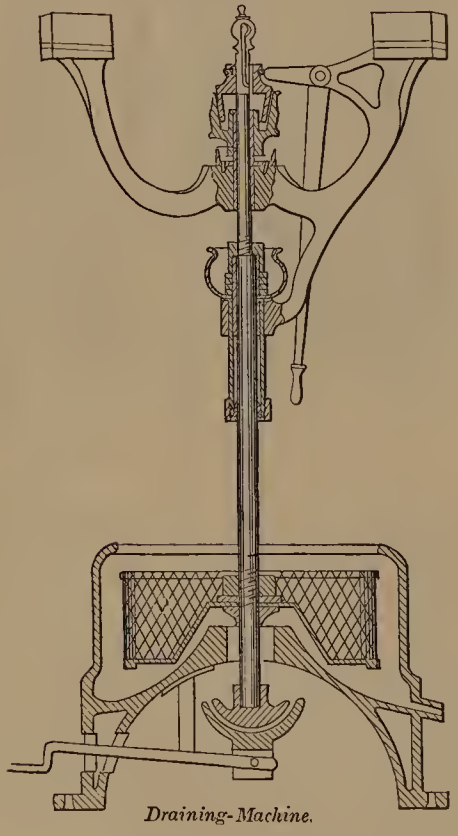
The engines were designed and constructed by Gibbs and Dean, English engineers, and the proof of quality is that upon occasion the engines have worked up to a duty of 87,000,000 pounds. The cost of the machinery and building was about $750,000.

The mere is now a tract fully subdued to the purposes of agriculture.

For elevation and plans in details of the engines, see "Civil Engineer's and Architect's Journal," Vol. X.: London, 1847.

Drain'ing-ma-chine'. A form of filter or machine for expediting the separation of a liquid from the magma or mass of more solid matter which it

Fig. 1743.



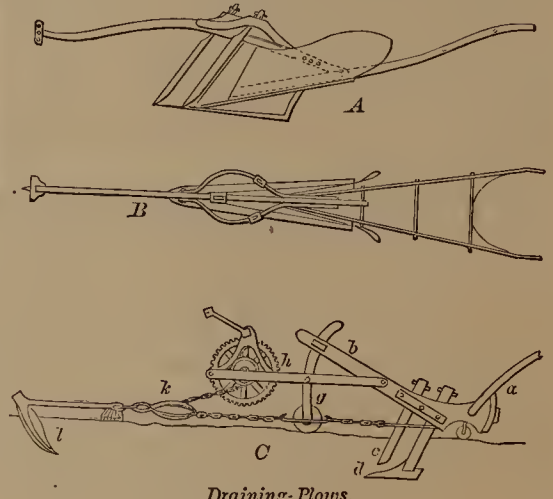
Draining-Machine.

saturates. It consists of a revolving vessel with perforated or wire-gauze outer surface, which allows the fluid portion to escape while it retains the solid particles. It is much used in draining sugar. See CENTRIFUGAL MACHINE.

Drain'ing-plow. A ditching-plow. A favorite English kind has three colters, two moldboards, and a share. It is shown at *A B* (Fig. 1744). The middle colter is vertical, and splits the soil in the middle of the furrow; the two side cutters are inclined, to cut the sloping sides of the ditch; the share cuts the bottom of the ditch, and the moldboards lift the soil in two slices, which are deflected laterally and delivered on the respective sides of the ditch. The usual dimensions of a ditch thus made are 12 inches deep, 15 inches wide at top, and 8 inches at the bottom.

Fowler's draining-plow (English) was exhibited in 1850, and was peculiar in the respect that it laid the drain-tile in its rear. The plow had a *mole* at the

Fig. 1744.



Draining-Plows.

end of the sharp, broad standard, and attached to the mole was a rope upon which the sections of drain-tile were strung. As the *mole* advanced, it drew in the string of tiles.

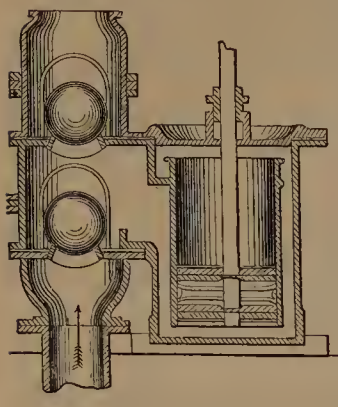
When it is desired to cut a trench deeper than can be effected by the ordinary mode of using the plow, the arrangement shown at *C* (Fig. 1744) is employed.

An anchor or hook *l* is inserted in the ground, affording a fixed point of resistance to the pulley *k*. Force is applied to the handle at the top, which communicates motion to the wheel *h*, with a very great increase of power, and the acting portions of the plow *c d* are forced through the soil. The arrangement at *a b* enables the conductor to give the required depth to the furrow. A roller *g*, resting on the ground, supports the forward portion of the plow. See EXCAVATOR.

Drain'ing-pot. (*Sugar-manufacture.*) An inverted conical vessel in which wet sugar is placed to drain.

Drain'ing-pump. A pump (*pompe castraise*) for elevating water containing sand and gravel. The single cylinder is open both at top and bottom, and is traversed by a piston without a valve. The cylinder is inclosed in a larger vessel, water-tight, which is itself filled with water. This larger vessel is divided into two equal parts vertically, by a partition which joins the working cylinder, so that the cylinder itself forms a part of the division. One extremity of the cylinder communicates with the cavity on one side of the partition, and the other with the opposite. The four valves are large balls of india-rubber, loaded in the interior with lead. They are contained in separate boxes by the side of the principal box, and are in communication by pairs with the two cavities into which that box is divided.

Fig. 1745.

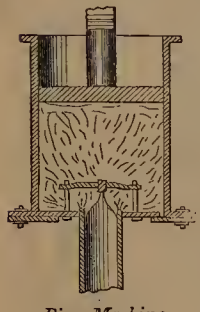


Draining-Pump.

The figure given shows a section of the cylinder, and a view of the arrangement of the pair of valves corresponding to the nearer half of the cylinder reservoir. The piston is represented as at the bottom of the stroke; as it rises the lower valve is raised by aspiration and water enters; as the piston descends the lower valve closes and the upper one rises to allow the water to flow out. The other pair of valves (not shown) have their induction and eduction by the depression and elevation of the piston respectively.

Drain-pipe. 1. (*Brewing.*) The pipe through which the *wort* is drawn from the *mash-tub* to the *under-back*.

Fig. 1746.



Pipe-Machine.

2. (*Husbandry.*) Clay pipe, known as drain-tiles, laid beneath the surface of the soil below plow depth, in order to carry off superfluous water and increase the fertility and ease of working the soil. See TILES.

The tempered clay being placed in a cylinder, the piston is depressed and the clay exudes through the annular throat of the *dod*, forming a continuous cylinder which is cut by a wire into sections of the required length.

Drain-tile. Drain-tiles are of many forms. See TILE.

They are usually laid by opening a cutting in the ground as narrow at top as can be conveniently worked, and at bottom forming a smooth bed in which the tile fits. The spades for this purpose are made tapering, and of different sizes. See SPADE; DRAIN.

Gibbs's plow for opening the ground was used in England about twenty years since, and made a trench with vertical sides, of the width for the tile to lie in.

Fowler's machine for laying drain-tiles was a mole-plow for making holes in the ground at a depth of from 2 to 4 feet, and drawing into the hole thus made a rope upon which a succession of drain-tiles was strung.

It has an apparatus attached for raising or sinking the plow, so as to lay a level drain under an uneven surface; it is drawn by the power of a windlass, and one horse's power exerted there will move the plow a yard in twenty seconds at a depth of 2 feet 6 inches. Three horses, four men, and six boys will keep two plows going, and lay 4,000 feet in a day at a depth of 3 feet. See DRAIN-PLOW; MOLE-PLOW.

A hole requires to be dug for the machine at every hundred yards, or six for an acre.

Drain-trap. A device for allowing water to pass off without admitting the passage of air through the duct. See STENCH-TRAP.

Drain-well. A pit sunk through an impervious stratum of earth to reach a pervious stratum and form a means of drainage for surface water, or a means of discharge of such liquid waste from manufactories as would foul the running water of streams. Such wells are properly termed *absorbing-wells* (which see), and by Arago are called *negative artesian-wells*, — a term more curious than profound. In former times the plain of Paluns, near Marseilles, was a morass, but was drained by means of absorbing-wells dug by King René; the waters thus carried off are said to have formed the fountains of Mion, near Cassis. The lake of Joux is supplied from the river Orbe in the Jura and the lake of Rousses, and has no visible outlet. It, however, maintains about an even level, and has evidently, as observed by Saussure, "subterranean issues by which the waters are engulfed and disappear." The inhabitants of this valley keep up their absorbing-wells with care, and open new ones 15 to 20 feet in depth whenever the surface water appears to be too slowly carried off. The waters reappear in a large spring called Orbe, two miles below the southern extremity of the lake, issuing at a point 680 feet below the level of the surface of the lake.

A potato-starch manufactory at Villetaneuse, three miles from St. Denis, France, is rid of 16,000 gallons of fetid waste water per day, with what effect upon neighboring or distant wells or springs does not appear. The town of Alexandria, Virginia, is situated upon an impervious clay of from 10 to 15 feet thickness, and a common mode of house and closet drainage is by wells which reach through this stratum into the sand substratum beneath. Good for the houses, bad for the wells of drinking-water.

Drap-d'été. (*Fabric.*) Summer cloth twilled like merino.

Draught. See DRAFT.

Draughts. See CHECKERS.

Draw; Draw'ing. A tension. The term forms part of compound words concerned in the draft of railroad-cars. Such are draw gear, head, link, spring, etc.

It also describes other attenuating processes, as the pulling of wire through an aperture in the DRAW-PLATE (which see).

The lengthening of a heated rod by hammering.

The action of rollers and other tension on slivers or rolls of fiber. See DRAWING-FRAME.

2. (*Founding.*) Said of a pattern whose shape is such that it may be withdrawn from the sand without breaking the molded form. *Delivery; draft, taper.*

3. (*Spinning.*) The *gaining* of the mule-carriage; its progress after the feed is stopped draws out the yarn.

Draw-bar. An iron rod to connect a locomotive with a tender.

Draw-bench. A machine for drawing slips of metal through a gaged opening. See DRAWING-BENCH.

Draw-bore. (*Carpentry.*) A hole so made through a tenon and mortise that the pin will draw up the shoulder to the abutment. The hole through the tenon is bored at a distance from the shoulder less than the thickness of the cheeks measured between the hole through the mortise and the face of the abutment against which the shoulder is drawn.

Draw-bor'ing. The operation of polishing a musket-barrel after it has been rifled.

Draw-boy. (*Weaving.*) Formerly the boy who pulled the cords of the harness in figure-weaving. A term sometimes applied to the mechanical device which forms a substitute for the boy. See JACQUARD.

Draw'-bridge. A form of bridge in which the span is removable from the opening to allow masted vessels to pass, or to prevent crossing.

The earliest mention of these is in the Egyptian monuments, where Rameses II. celebrated his victories over fortified cities, 1355 B. C. He is supposed to be the Sesostris of Herodotus and Diodorus. The sepulchral and palatial paintings represent the bridges as crossing the moats around castles and fortified towns.

Drawbridges are used in crossing canals, rivers, and dock entrances, which are occasionally traversed by masted vessels.

They are also used in crossing the ditches, fosses, and moats of fortifications.

They are of four kinds: —

1. The *lifting*.
2. The *swing*.
3. The *bascule*.
4. The *rolling*.

1. The *lifting-bridge* is used in Holland upon the canals and in fortifications, in places where the roadway is near the level of the water. The bridge is lifted bodily and supported by a heavy framework, while the vessel passes. See LIFTING-BRIDGE.

2. The *turning*-bridge or *swing*-bridge moves on a vertical pivot, being sometimes in two sections which meet half-way across the water-course. The portion on land is a counterpoise for that projecting over the water, and the bridge moves in arc-shaped tracks resting on cannon-balls. See SWING-BRIDGE.

It is sometimes supported by a central post and swings 90°, opening two passages for vessels, one on each side. This is a *pivot*-bridge.

3. The *bascule-bridge* turns on a horizontal pivot, standing in a vertical position on the side of the water-way while the vessel passes by. The inner end is in excess of the weight of the roadway and descends

Fig. 1747.

Rolling-Bridge.

into a pit built with hydraulic masonry. This pit is not material, perhaps, in fortifications, but is not desirable in ordinary road or dock work. The *bascule* may be seen at Havre and Hull. See BASCULE-BRIDGE.

4. The *rolling-bridge* has been introduced on some English railways. The bridge passes laterally upon a carriage until it has passed the junction of the line of rails, and then rolls inward to leave the water-way clear.

In the example, the movable cars or platforms are suspended by rods and form traveling trucks, which run upon rails laid on the top of metallic tubes supported on pillars, and which serve also as viaducts, by which means the crossing of streams is afforded to traffic and travel. The tubes are to be elevated sufficiently to allow vessels to pass under the same.

Draw-cut. An oblique motion of a knife, so as to move lengthwise across an object as well as cutting into it.

Draw'er-lock. A form of inside or mortise lock which projects its bolt upwardly into the strip above.

Draw-fil'ing. Drawing a file longitudinally of a piece of metal without giving the file any movement in the direction of its length.

Draw-gage Cut'ter. A harness-maker's tool for cutting strips of leather of any set width. See GAGE-KNIFE.

Draw-gate. The valve of a sluice, either of a canal, a flushing arrangement, or a flume or penstock of a water-wheel.

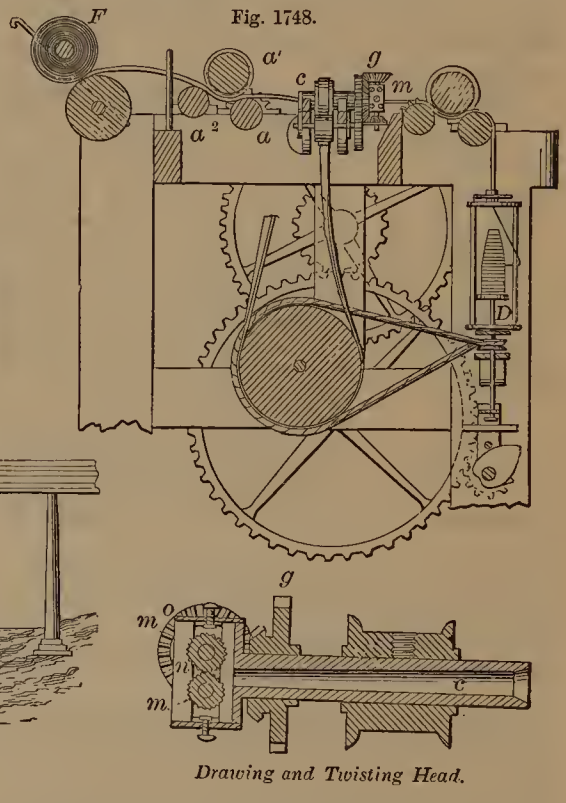
Draw-gear. The coupling parts of railroad-cars. See CAR-COUPLING.

Draw-head. 1. (*Railway.*) The projecting part of a draw-bar in which the coupling-pin connects with the link. See CAR-COUPLING.

2. (*Spinning.*) A device in spinning in which the slivers are lengthened and receive an additional twist.

A form of draw-head which lengthens the roving and twists it simultaneously is shown in Fig. 1748.

Fig. 1748.



Drawing and Twisting Head.

The process is effected in small space at one operation by means of the combined condensing-tube *c* and draw-rollers *m m*. These latter are adjustably journaled in a box *n* at the end of the tube *c*, so that they revolve with the tube on a common axis passing through the center of the tube and between the rollers. This revolution is effected by belt and pulley. They have, however, an independent motion on their own axis, at right angles to this common axis, which is derived from independent bevel-gears *o g*. The roving from the spool *F* is drawn by the first set of take-up rollers *a a' a²* into the condensing-tube, thence passing through the drawing-rollers *m m*, whose speed of rotation on their independent axis may be so adjusted relatively to their rotary motion in common with the tube *c* as to give any required degree of twist. The yarn then passes to the second set of take-up rollers, and thence to the spindle *D* as usual.

Drawing. 1. (*Fiber.*) Extending a sliver for the purpose of drawing its fibers parallel and increasing its length. The *drawing* and *doubling*

process first draws out the slivers as produced by the finishing card by means of drawing-rollers, and then unites several of these into one. The object of the first operation is to draw each fiber past the next one, thus placing them still more completely parallel to each other; while that of the second is to neutralize the inequalities in each separate sliver, and to strengthen them after having been extended. See DRAWING-FRAME.

The *drawing* of long wool for worsted is somewhat similar to the operation with cotton. The slivers are combined, attenuated, and twisted ready for the farther operation of *spinning*.

Flax is drawn in substantially the same manner as cotton, some modifications in the arrangements adapting the machinery to the material.

The hackled flax, having been carefully sorted into grades of quality by the *sorter*, is spread upon a feeding-cloth by hand, in such a manner that the forward ends of each *strick* reach to the middle of the preceding one, so as to preserve a uniform thickness on the feed-cloth, the *stricks* of hackled flax being smaller at the ends than in the middle.

The flax is thus fed to one pair of rollers, which deliver it through *gills* or hackle-points to a second pair of rollers revolving at a greater speed. It is then conducted to a can.

These *slivers* are next taken to the spreading-frame, where a number of them are laid together and drawn into one length by passing between consecutive pairs of rollers, each pair rotating at a rate above that of its predecessor.

The arrangements vary in the production of different yarns, but in a given case eight slivers may be drawn into one in the first frame, twelve into one in the second, fifteen into one in the third.

Fig. 1749.

Drawing Flax.

The sliver when sufficiently equalized and attenuated proceeds to the *roving-machine*, which gives it a slight twist and winds it on bobbins ready for *spinning*.

2. (*Weaving.*) The arrangement of the heddles in accordance with the requirements of the ornament to be exhibited. The *draft* or *cording* of the loom.

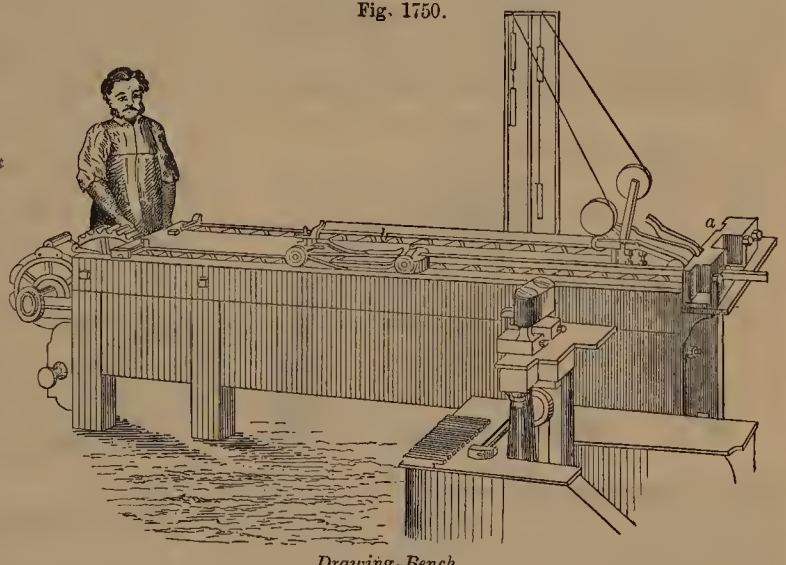
3. The making or copying of plans, and views of buildings, machinery, and other structures.

In this connection we have the compound words: —

Drawing-board.	Drawing-pen.
Drawing-compass.	Drawing-pencil.
Drawing-paper.	Drawing-slate, etc.

4. (*Metal-working.*) The operation of hammering, rolling, or drawing through a die, by which a bar or rod of metal or a wire is extended in length to form a rod, tube, or plate.

Fig. 1750.



Drawing-Bench.

Draw'ing-awl. (*Leather.*) A leather-worker's awl, having a hole near the point in which the thread is inserted and pushed through in sewing, etc.

Draw'ing-bench. An apparatus invented by Sir John Barton, formerly comptroller of the British Mint. Strips of metal are brought to an exact thickness and width by being drawn through a gaged opening, made by two cylinders in the required proximity and prevented from rotating.

The cylinders are fastened in a head *a* at one end of a bench, and the sharpened end of the metallic strip is thrust through them so as to be grasped by a pair of jaws on a carriage *b*, which is retracted by an endless chain. When the strip has passed through the throat, it is automatically disengaged from the jaws, and the carriage returns. The operation is similar in principle to that of drawing wire through a *draw plate*.

Draw'ing-board. A square frame, with either a continuous surface or a shiftable panel, for holding a sheet of paper while plotting, projecting, etc.

Draw'ing-com'pass. An instrument with two legs, used for striking circles and curves. One leg has a *pen* or *pencil*, and it has several modifications, such as *bow-pen*, *bow-pencil*, *beam-compass*, etc.

Compasses for measuring and transferring measurements are called dividers, bisecting-compass, proportional compass, etc. See COMPASS.

Draw'ing-frame. 1. A machine in which the *slivers* of cotton or other wool from the carding-machine are attenuated by passing through consecutive pairs of rollers, each successive pair rotating at a higher speed than its predecessors.

The device was first invented by Leon Paul, patented 1738; and perfected by Arkwright, patent

1769. It was called a *water-frame*, from the circumstance that Arkwright's machinery was driven by water-power.

It was named a *throstle* from the brisk singing or humming sound made by it. See THROSTLE.

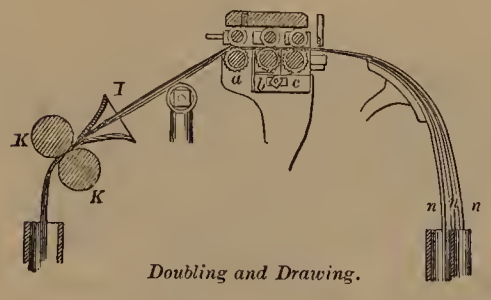
It is used in the process of doubling slivers (see DOUBLER), and is indispensable in the *bobbin-and-fly machine* and the *mule* (which see).

The *drawing-frame*, disconnected with any spinning operation, is a machine to elongate the spongy slivers produced by the carding-engine, to straighten the filaments and lay them parallel.

The drawing-frame is also used to equalize slivers by condensing a number into one (see DOUBLING), and then elongating them so as to overcome special defects. Filaments which have become doubled over the teeth of the carding-machine are also straightened in the process of doubling and drawing.

The *drawing-frame* consists of three pairs of rollers, the upper ones being covered with leather and the lower ones fluted longitudinally. The upper ones have an imposed weight, and the lower ones are driven by power, and carry those above. The rollers are driven with varying degrees of velocity; the second *b*, say, at a speed double that of the first *c*, and the third or delivery rollers *a* at a speed five times that of the second *b*.

Fig. 1751.



Doubling and Drawing.

The delivery-rollers, called the *front*-rollers, turn in brass lushes in fixed iron bearings, but the other roller-brasses are adjustable in grooves towards and from each other and the front roller, to adapt their distances to the length or staple of the cotton operated upon.

The *card-ends* or slivers *n m*, from separate cans, are united and pressed together between the rollers (*doubling*), and by the increased speed of the successive pairs are drawn out into a flat sliver, two of which are combined, passed through a funnel *I*, between compacting rollers *K K*, and thence to a can. A board above the upper rollers has flannel on its lower surface, and acts as a wiper.

The operation is as follows: —

Suppose six slivers from the carding-machine, or *card-ends*, to be inserted and passed through the first pair of rollers, the second pair, traveling at double the rate of the former, will elongate every inch of the compound sliver into two inches, and the third will make it ten inches, so that the combined sliver is formed into one of ten times the length and proportionate size; this process is repeated again and again, so that in very fine yarn the fibers are laid parallel to each other many thousands of times, and with coarse yarns as many as a thousand times. For instance: —

Ten card-ends formed into one ribbon of the same size and six times the length; six of these ribbons similarly treated and formed into one; six of the latter, by a third operation, formed into one sliver; and five of these drawn into one,— will have the effect of placing the fibers parallel to each other 1080 times ($6 \times 6 \times 6 \times 5 = 1080$).

The drawing-frame for long-stapled wool is for drawing out and extending the slivers which have already been operated upon by the BREAKING-FRAME (which see). This is a repetitive operation, and it is usual to pass the wool through the *breaking-frame* and four times through the *drawing-frame* before *roving*. These slivers are united at each drawing, and are extended to, say, four times the length. The result is an actual extension and an oft-repeated laying of the slivers alongside of each other, so as to blend them and reduce inequalities.

2. (*Silk-machinery.*) A machine in which the fibers of floss or refuse silk are laid parallel, preparatory to being cut into lengths by the *cutting*-engine, to be afterwards worked like cotton.

The order of the machines is as follows: —

Hackling.

FILLING-ENGINE (which see).

Drawing-frame; the filaments are held firmly by one end, and a comb travels over the surface to remove impurities and short fibers.

Cutting-engine reduces the filaments to a staple about $1\frac{1}{4}$ inches in length.

Scutcher.

Cleanser and *dryer.*

Carding-machine.

From whence the staple is treated like cotton. See CARDING-MACHINE; DRAWING; DOUBLING; ROVING-MACHINE; THROSTLE; BOBBIN-AND-FLY FRAME, etc. See list under COTTON, etc., p. 631.

Draw'ing-in. (*Weaving.*) The process of arranging the yarn threads in the loops of the respective *heddles.*

Draw'ing-knife. 1. A blade having a handle at each end, and used by coopers, wagon-makers, and carpenters. It is usually operated in connection with a shaving-horse, which holds the stave, spoke, shingle, axe-handle, or other article which is being shaved.

2. A tool used for cutting a groove as a starting for a saw-kerf.

Draw'ing-ma-chine'. 1. One for elongating the soft roving of fiber. See DRAWING-FRAME.

2. One for drawing a strip of metal through a gaged opening to equalize its size. See DRAWING-BENCH.

3. A form of spinning-machine for ductile sheet-metal.

Draw'ing-pa'per. A variety of large white paper, made preferably of linen stock, and of 14 sizes.

The sizes of drawing-paper are, —

Cap	13	× 16	inches.
Demy	15.5	× 18.5	"
Medium	18	× 22	"
Royal	19	× 24	"
Super-royal	19	× 27	"
Imperial	21.25	× 29	"
Elephant	22.25	× 27.75	"
Columbier	23	× 33.75	"
Atlas	26	× 33	"
Theorem	28	× 34	"
Double Elephant	26	× 40	"
Antiquarian	31	× 52	"
Emperor	40	× 60	"
Uncle Sam	48	× 120	"

These are about the usual sizes, but the scales of different makers vary to some extent.

Draw'ing-pen. A pen for ruling lines, consisting, in its most usual form, of a pair of steel blades, between which the ink is contained, the thickness of

Fig. 1752

Drawing-Pens.

the line being determined by the adjustment as to distance of the said blades.

The ends of the steel blades are elliptical, sharp, and exactly even. A *ruling-pen*. A *straight-line* pen.

a is a *single*-drawing pen.

b, a *double*-drawing pen, for ruling two lines at once.

A *dotting*-pen makes a succession of dots, being formed of a roulette rotating in a stock. See DOTTING-PEN.

Draw'ing-pen'cil. A black-lead pencil of hard quality, made especially for drawing lines. See LEAD-PENCIL.

Fig. 1753.

Drawing-Pins.

Draw'ing-pin. A flat-headed tack for temporarily securing drawing-paper to a board. A *thumb-tack*.

Draw'ing-pli'ers. (*Wire-drawing.*) The nippers whereby the wire is grasped when pulling through the draw-plate.

Draw'ing-point. A steel tool for drawing straight lines on metallic plates. A scriber for metal. The *draw-point* or *dry-point* of an engraver makes its mark directly upon the metal, and not as the etching-point, which makes a mark through a ground, the line being subsequently eaten into the metal by acid. See ETCHING.

Draw'ing-rol'ler. The fluted roller of the drawing-machine, elongating the sliver. See DRAWING-FRAME.

Draw-kiln. A lime-kiln arranged to afford a continuous supply of lime from below, fuel and limestone being fed in above from time to time. Also called a *running-kiln*, or *continuous kiln*.

Draw-link. A connecting link for railroad cars. See CAR-COUPLING.

Draw-loom. (*Weaving.*) The draw-loom was the predecessor of the *jacquard*. It is used in figure-weaving. The number of the *heddles* being too great to be worked by the feet of the weaver, the warp-threads are passed through loops formed in strings, arranged in a vertical plane, one string to every warp-thread; and these strings are arranged in separate groups, which are pulled by a *draw-boy*, in such order as may be required to produce the pattern. The groups are drawn by pressure on handles, the required order being determined by reference to a design, painted on paper, which is divided up into small squares.

A mechanical draw-boy has been contrived, to dispense with human assistance. It consists of a half-wheel with a rim grooved so as to catch into the strings requiring to be pulled down. The half-wheel travels along a toothed bar, with an oscillating motion from right to left, and draws down the particular cords required for the pattern.

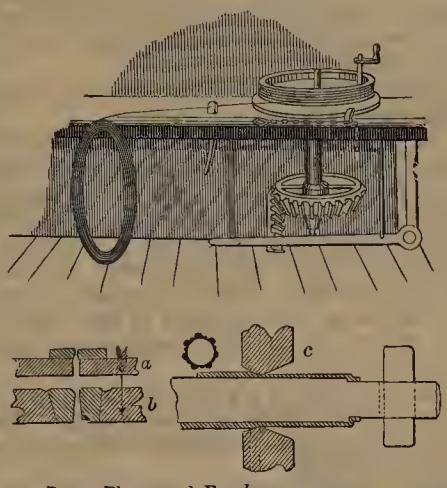
Drawn-brush. One in which the tuft or *knot* is drawn into the hole in the stock by a loop of copper wire.

This generic description includes hair, scrubbing, shoe, clothes, nail, and tooth brushes.

Draw-plate. A drilled steel plate or ruby through which a wire or ribbon of metal is drawn to reduce and equalize it.

a represents a ruby draw-plate for gold or silver wire.

Fig 1754.



Draw-Plates and Bench.

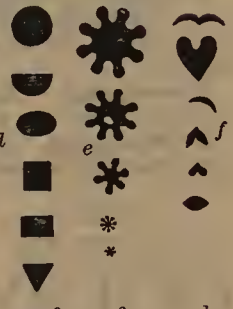
b a draw-plate for evening the pendulum springs for chronometers.

c is a draw-plate of metal for tube drawing.

d are sections of wire of various shapes drawn through plates.

e represents forms of pinion wire.

f shows fancy forms of wire used with others as pins in the surface of a wooden block used in calico-printing.



The essential feature of wire-drawing is the *draw-plate*. This was probably known at Nuremberg early in the fourteenth century, and how much before is not apparent. The "History of Augsburg," 1351, and that of Nuremberg, 1360, mention the "wire-drawer" (*Drahtzieher*). The draw-plate was imported into France by Archal, and into England by Schultz (1565). The drawplate is probably an Oriental invention.

The draw-plate is made of a cylindrical piece of cast-steel, one side being flatted off. Several holes of graduated sizes are punched through the plate from the flat side, and the holes are somewhat conical in form. The wire is cleaned of its oxide in a tumbling-box, and is then annealed. It is then drawn through as many of the holes in succession as may be necessary to bring it to the required size. The wire is occasionally annealed to remove the hardness incident to compression in the plate, and the wire pickled to remove scale.

The sharpened end being passed through a hole in the plate, the wire is drawn through sufficiently to attach it to the wheel. This, being revolved, draws the wire through the plate and reels it up as drawn. The coil from which it is drawn is dampened with starch-water or beer-grounds as a lubricator. The Hindoo Sonârs, who are noted for their dexterity in drawing gold-wire, use castor-oil as a lubricator. Wax and tallow are commonly employed.

Strips and angle-iron of metal are made by passing through draw-plates of the required shape. The pinion-wire for watches is thus made, and also strips and rods of various forms, which are cut in sections and driven like pins into the hubs of calico-rollers, forming the dots, leaves, etc., of patterns.

For fine work, such as the drawing of gold and silver wire, the draw-hole is made of a drilled ruby. The wire for pendulum-springs of watches is drawn through a pair of flat rubies with rounded edges.

Tubes for telescopes are drawn upon a mandrel.

Gun-barrels, boiler and condenser tubes, lead-pipe, slips for music-type, window-lead, etc., are also drawn, or may be.

French *draw-plates* are described as being made by the following process: —

A piece of wrought-iron is prepared 1 inch thick, 2 broad, and 12 long. This is furrowed on one side by the peen of a hammer, so as to receive a layer of partially decarburetted cast-iron, called *potin*. This potin is made by breaking up pieces of a new iron pot, fusing them again and again with charcoal, and quenching in water. The iron partially "comes to nature," assuming the condition of steel, and is eventually melted on to the wrought-iron plate and welded thereto.

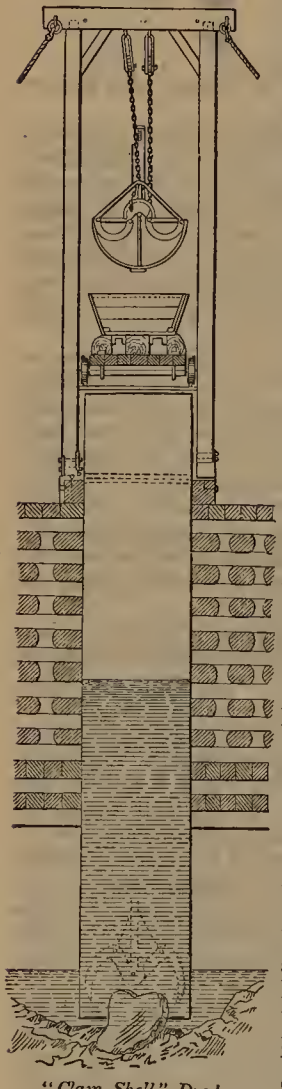
The holes are made by a punch while the iron is hot, and are very numerous in a single plate. The holes are tapered, the base of the cone being on the side of the wrought-iron.

Brockedon's English patent, 1819, specifies the use of diamonds, rubies, sapphires, and other hard gems, drilled for draw-eyes and mounted in iron plates.

Draw-point. (*Engraving.*) The etching-needle used on the bare plate. *Dry-point.*

Draw-spring. The spring of a *draw-head.* A spring coupling-device for railroad cars.

Fig. 1755.



"Clam-Shell" Dredge.

Draw-tube. The adjustable tube of a compound microscope, having the eye-piece at its outer end, and the erecting-glass (if any) at its inner end.

Dray. A low cart of an ancient type. The shafts are prolonged to form the rails, and the load is rolled upon the rear of the inclined bed.

Dread'naught. (*Fabric.*) *a.* A heavy, woolen, felted cloth, used as a lining for hatchways, etc., on board ship.

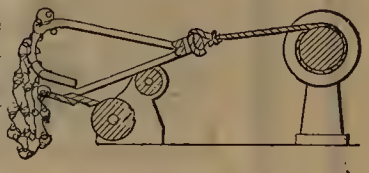
b. A heavy goods for sailors' wear.

Dredge. A scraper or drag-net for gathering mud, sand, or oysters, as the case may be, from the bottom. Mud is dredged to improve the channel, sand for making mortar, oysters from their beds, for food.

A bucket or scoop for scraping mud, sand, or silt from the bed of a stream, pond, or other body of water. Such are usually on endless chains. See DREDGING-MACHINE.

The "clam-shell" dredge used for removing the excavated material from the working-chamber of the East River, New York, bridge caisson, consists of a pair of scoops which are hinged to an axis and close upon the load, whether a mass of mud or gravel, or boulder of moderate size. The dredge ascends and descends in a vertical water-shaft in which the water rises as high as its natural level on the outside of the caisson. The view shows a portion of the working-chamber through which the dredge-shaft passes, and the numerous layers of timbers which form the roof of the working-chamber and support the masonry of the pier. The dredge is lifted with its load by the tackle above, and, being suspended above the car, the contents are dumped into the latter by shifting the points of suspension of the latter to the chains which are connected to its outer corners; this causes the scoop to gape open and spill its contents. The car is then run down an incline, and dumps its load into a lighter alongside the caisson.

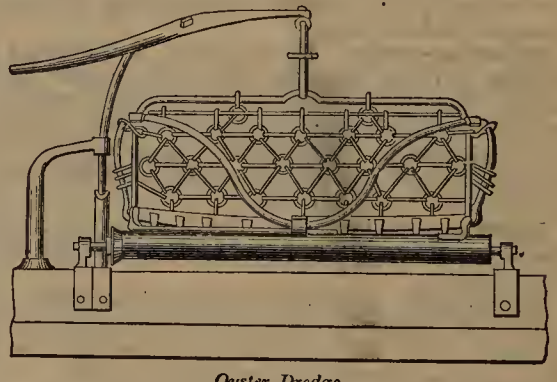
Fig. 1756.



Oyster-Dredge.

A rake and bag dragged over an oyster-bed to detach and gather the bivalves. The dredge is towed

Fig. 1757.



Oyster-Dredge.

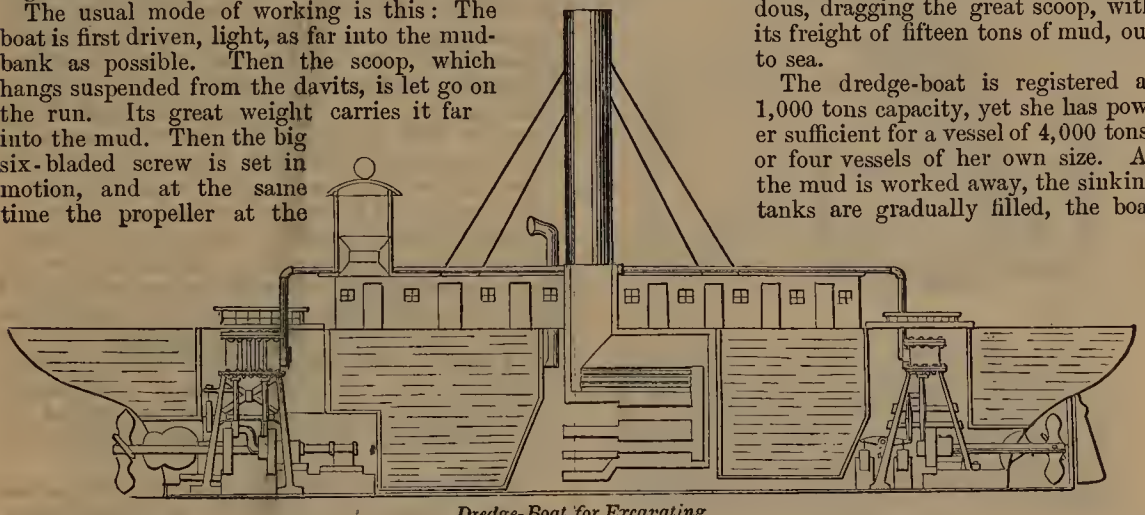
by a sail-boat, and by hand or tackle is lifted by a lever swung from a davit, and is eased over the side by a roller mounted on the gunwale, as shown in Figs. 1756, 1757. See NET; TRAWL.

Dredge-boat. A form of dredging-machine in which the boat becomes its own grubber, the depth at which the mud-fan shall operate being regulated by introduction of water into compartments of the vessel. The dredger may operate by plowing a channel through a sand or mud bar, the latter presumably, as it has been constructed to keep open the mouths of the Mississippi, allowing the current to carry off the loosened matter. A scoop is, however, to be rigged forward to plow into the mud, when the dredger will back off with its load, carry it out to sea, and dump it. The length of the vessel is 154 feet 8 inches; depth of hold, 30 feet, and about 23 feet beam. She has a screw at the after end with 3 blades, 12 feet diameter and 14 feet pitch, for propelling exclusively; and one at the forward end with six blades, 14 feet diameter, and weighing 23,900 pounds. This screw performs two offices: impelling the vessel through the water by a drawing-on process, and digging into the mud and sand. It is worked by two oscillating engines, 40-inch bore and 4-feet stroke. The three-bladed propeller is driven by a similar single oscillating engine. The steam is generated in five tubular boilers amidship. Besides the six-bladed screw for digging, there is also a large scoop or drag, in the shape of a half-cylinder, 12 feet deep, 20 feet long, and will drag

away fifteen tons of mud or sand at a load. This scoop is suspended from two davits overhanging the bow, and is managed by a pair of hoisting-engines forward.

The usual mode of working is this: The boat is first driven, light, as far into the mud-bank as possible. Then the scoop, which hangs suspended from the davits, is let go on the run. Its great weight carries it far into the mud. Then the big six-bladed screw is set in motion, and at the same time the propeller at the other end commences whirling to pull the boat off. The six-bladed propeller loosens up the mud and adds to the impelling power, which, when both are working, is tremendous, dragging the great scoop, with its freight of fifteen tons of mud, out to sea.

Fig. 1758.



Dredge-Boat for Excavating.

The dredge-boat is registered at 1,000 tons capacity, yet she has power sufficient for a vessel of 4,000 tons, or four vessels of her own size. As the mud is worked away, the sinking tanks are gradually filled, the boat settles deeper in the water, and the digging-apparatus works in deeper mud.

Dredg'er. 1. (*Hydraulic Engineering.*) A ballast-lighter. A barge or scow which scrapes silt from the bottom of a stream. See DREDGING-MACHINE.

2. (*Domestic.*) A box with a perforated lid for sprinkling flour upon dough or a dough-board. A *dredge-box.*

Dredg'ing-ma-chine'. (*Hydraulic Engineering.*) A machine for raising silt, mud, sand, and gravel from the bed of a stream or other water, to deepen the channel or to obtain the material for ballast or for filling low grounds.

The dredging-machine with a box shovel on the end of an oscillating arm is supposed to have originated in Venice. It had a beam 50 feet in length, moving on a pivot-post erected in a barge whose length was 50 feet and breadth 22. The beam was hooped with iron, and worked by a perpendicular screw of beech 30 feet long and 15 inches in diameter, traversing in a nut in the beam, and moved by bars in the manner of a capstan. A large iron spoon, holding 2½ cubic yards and provided with a lid, was fixed to the outer end of the beam. To this spoon a certain rotation was given by means of ropes and

Fig. 1759.

Dredgers.

pulley, the lid opening by one motion and the spoon filling with mud by a second motion. Rotation of the screw then depressed the inner end of the beam, raising the outer end. It took fifteen minutes to raise a single scoopful. Eight men in a day would raise 60 cubic yards.

A common and cheap form of this machine, by which sand is procured from the bottom of rivers, consists of a large shovel on a long handle, suspended by a rope either from a crane or a sweep-pole. The shovel, being lowered, is thrust into the sand by one man, when the assistant proceeds to raise it and swing it round over the boat, where the contents are dumped.

This is something similar to the *bag and spoon* (Fig. 517), which consists of an iron ring with a steel lip, and a bag of strong leather laced through holes in the ring. The means for working it is a long handle, a suspending rope, and a crane or sweep-pole from a post in a barge, as in the last example.

About 1680, Meyer, a Dutch engineer, had a dredging-machine on the principle of the French chapelet; a long trough being lowered to the mud, and traversed by an endless chain provided with boards at intervals. The boards scraped up the mud and carried it up in the trough, from whose upper end it was discharged into lighters. A horse-wheel was employed.

In the reign of Charles I., Balme made a vertical wheel with six buckets, which worked between boats and raised mud. It was employed in the fens of Lincolnshire.

About 1708, Savery patented a steam dredging-machine for raising ballast from the Thames.

In 1796, Watt made a steam dredger for deepening Sunderland Harbor.

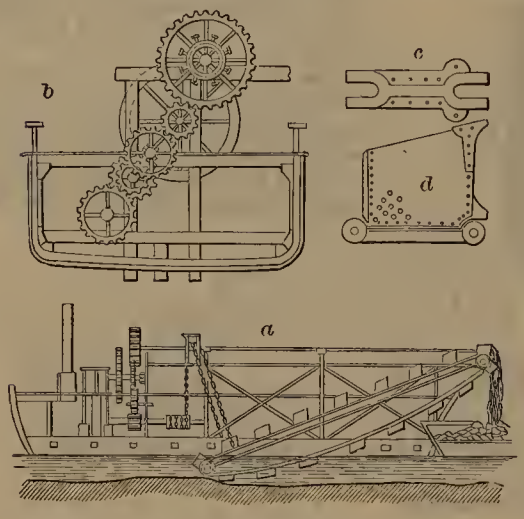
The dredging-machine described by the Marquis of Worcester was "a water-screw, but the bottom made of iron plate, spade-wise, which at the side of a boat emptieth the mud of a pond or raiseth gravel."

The dredging-machine described in the *Theatrum Instrumentorum et Machinarum*, 1578, was rather an elevator than a dredger. The buckets were attached to endless chains, which passed over two drums, driven by winch-power. Laborers filled the buckets.

The chapelet, used by Perronet and other French engineers in the last century for deepening channels and removing the mud from the interior of coffer-dams in preparing foundations for bridges, was composed of three rollers, two of which touched the ground, and the other was placed upon an elevated timber scaffold, where the mud and silt were deposited. Round these rollers worked an endless chain formed of large links, to which were attached four or more sheet-iron scoops or scuttles, placed at regular

distances. These scoops were pierced with holes to allow the water to run off, and had strong projecting

Fig. 1760.



Steam-Dredger.

beaks which dug into the mud or earth below. The chain was moved by cylinders whose projecting spikes entered the links of the chain; the cylinder was rotated by a winch. As the buckets became inclined after turning over the upper roller, their contents were discharged into a trough which conveyed away the mud.

The steam dredging-machine, now so commonly in use in harbors liable to become silted up, has a succession of buckets on an endless chain, which traverses on a frame whose lower end is vertically adjustable so as to regulate the depth at which it works, like the French chapelet.

It was first successfully used in England by Huges in 1804, who succeeded, after repeated trials, in making a machine, costing $40,000, which raised 2,000 tons per day from a depth of water of 30 feet.

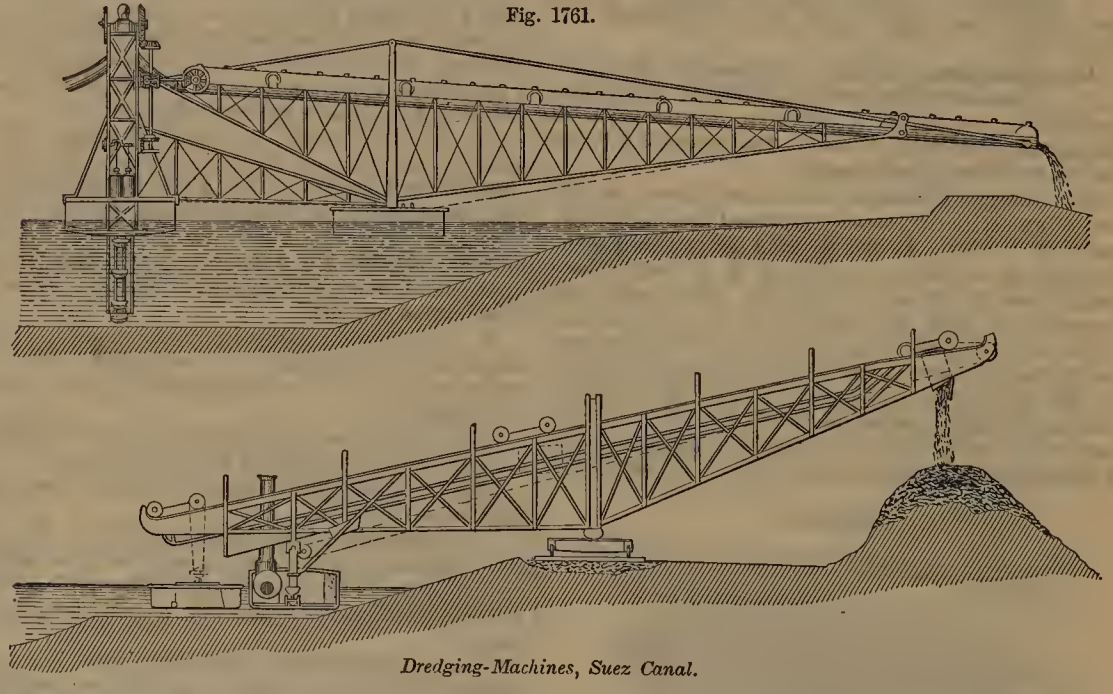
The machine is driven by a steam-engine through the intervention of gearing, steadied by a fly-wheel. A long shaft amidships conveys the motion from the gearing about the engine to the upper drum, around which the endless chain works. The buckets discharge at the stern of the vessel, dropping the mud into a lighter. The lower end of the swinging-frame is adjusted as to depth by means of a suspensory chain, which is wound upon a drum rotated by clutch-connection with the spur-gearing when necessary.

The illustrations show a longitudinal vertical section *a*; a transverse section *b*, on a larger scale, affording a view of the gearing; a plan of the link *c*, and an elevation of the bucket *d*. Each alternate link carries a bucket, which is of sheet-iron riveted to a link. The bucket and link are shown on a still more enlarged scale.

The best working-angle for the frame is 45°.

The dredging-machine used in excavating the

Fig. 1761.



Dredging-Machines, Suez Canal.

South Boston flats has a scow 80 feet long, 40 wide, and a dredge-shovel and chain of elevating-buckets on each side. They are advanced by chains running to anchored scows, the shovel beneath each elevator raising the mud and silt, and the buckets elevating the scooped-up mass, which is deposited in a scow attached to the dredger.

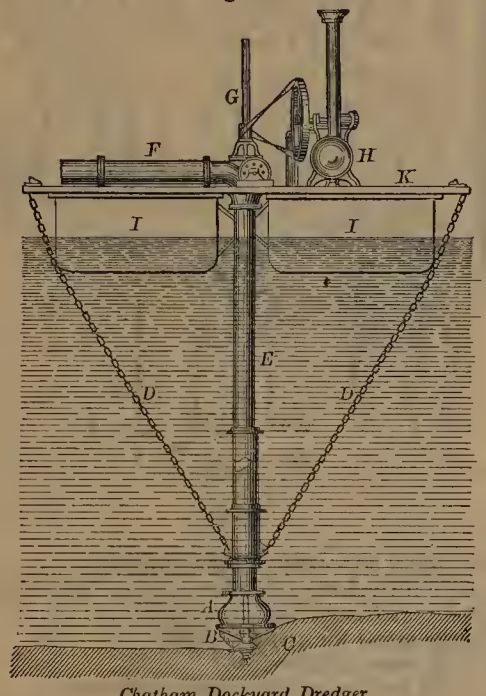
Duncan's dredger, used on the Clyde in Scotland, has an iron hull 161 feet long, 29 feet beam, 10 feet 9 inches depth; has water-tight compartments, engine-room, and quarters for the crew. It has one bucket-chain, thirty-nine buckets having a capacity of 13 cubic feet each; driven by gearing from a marine engine of 75 nominal horse-power. It is moved forward by a steam-winch and a chain to a mooring.

Sixty dredging-machines have been at work at one time in excavating the Suez Canal. They are of two kinds, as shown in the cuts, which need but little description to make them perfectly intelligible. The hulls are of iron, are 72 or 82 feet long; one form has a lighter which gives stability, and forms a rest for the chute, 230 feet long, which deposits the excavated material on spoil-banks, whose crests are 197 feet distant from the center line of the canal. The transporting-buckets have a capacity of about 5 cubic feet, and the delivery is twenty buckets per

minute. In the other view the chute rests on a carriage traveling a track on the canal-bank. In each case the buckets are loaded by the dredging-spoons, travel along the chute, capsize at the end, and return for another load. The spoil not deposited on the banks is dumped into lighters, and carried out and disgorged into the deep waters of the Mediterranean.

Another form of dredger, used at Chatham Dockyard, England, is of the rotary-pump class, having

Fig. 1762.

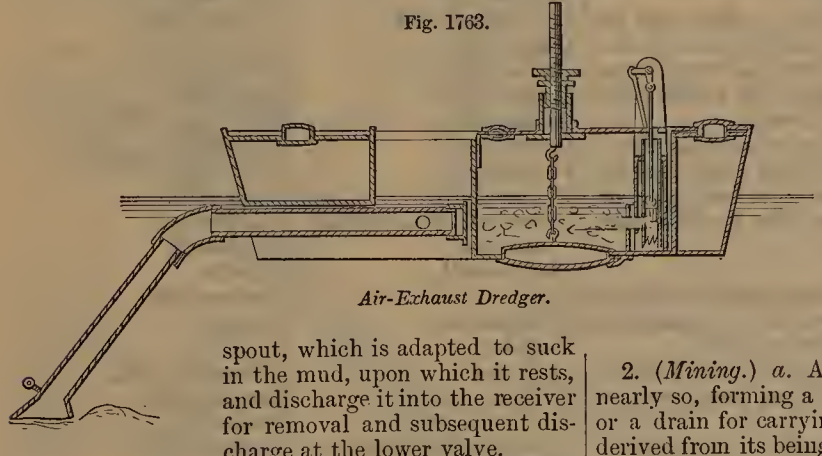


Chatham Dockyard Dredger.

a revolving disk *A* with an excavating screw *B*, an up-cast shaft *E*, and a spout *F* which discharges the material into a lighter alongside. The up-cast shaft is telescopic, and is stayed by guys *D*. The upwardly projecting rod *G* is the shaft of the revolving wheel, and is extensible coincidently with the telescopic tube. *H* is the steam-engine connecting by band-wheel and belt with the shaft *G* of the screw which excavates the mud *C*. *K* is a transverse beam of the frame which rests on twin boats *I I*.

Another mode of raising sand, silt, and mud is by an exhausted receiver in the barge, connected by an adjustable pipe and flexible connections with a

Fig. 1763.



Air-Exhaust Dredger.

spout, which is adapted to suck in the mud, upon which it rests, and discharge it into the receiver for removal and subsequent discharge at the lower valve.

The steam jet or ejector has also been used, or proposed. It differs in no substantial respect from the water-ejector. See EJECTOR.

Drench'ing-ap-pa-ra'tus. A jaw-opener and head-lifter by which drenches may be administered to animals without their being able to bite the bottle or horn, or the arm of the operator.

Drench'ing-horn. A cow's horn, closed at the butt-end and perforated at the point-end (like a powder-flask), to administer drenches of medicine to ailing animals.

Dress. Applied to the system of furrows on the face of a mill-stone. See MILL-STONE DRESS.

Dres'ser-cop'per. A vessel in which warps or threads are passed through boiling water.

Dress-guard. A wing on the side of a carriage entrance, to prevent the brushing of the dress against the wheel.

Dress'ing. Sizing of fabric, yarn, or thread.

Teaseling, or raising the nap on woolen cloth.

Preparation of mineral ores for the furnace.

Preparation of the surface of a mill-stone.

Smoothing the surface of plank or of stone.

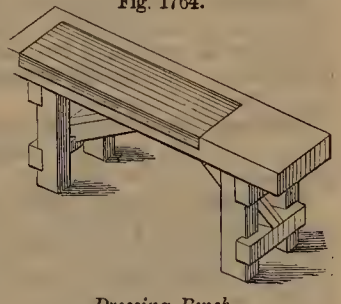
Glossing of crape-warp.

Arranging symmetrically the form in the chase.

The complete planishing of sheet-metal ware into symmetrical form, on a stake or anvil.

Dress'ing-bench. A bricklayer's bench having a cast-iron plate on which the sun-dried brick is rubbed, polished, and beaten with a paddle to make it symmetrical.

Fig. 1764.



Dressing-Bench.

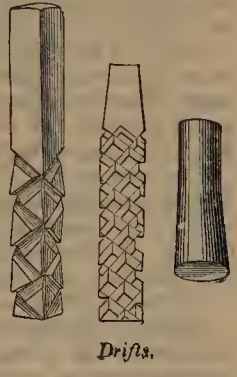
Dress'ing-machine'. (*For yarn.*) A machine invented by Johnson, England, in 1800. The hard-twisted yarn is sized, scraped, brushed, and dried by heat and a blast of air. The object is to remove the fuzz and give it a slight gloss.

Dress'ings. The moldings and sculptured decorations used on a wall or ceiling.

Drift. 1. (*Machinery.*) A round piece of steel, made slightly tapering, and used for enlarging a hole in a metallic plate by being driven through it.

The drift may have a cutting edge merely upon its advance face, or it may have spirally cut grooves which give the sides of the drift a capacity for cutting, as in two of the examples annexed.

Fig. 1765.



Drifts.

2. (*Mining.*) *a.* A passage in a mine, horizontal or nearly so, forming a road for the extraction of ore, or a drain for carrying off the water. The name is derived from its being *driven in*. *Driving* is horizontal work; *sinking* and *rising* refer to the direction

of work either in shafts or in following the course of a vein. See ADIT; GALLERY.

b. The course or direction of a tunnel or gallery.

3. (*Architecture.*) The *push*, *shoot*, or horizontal thrust of an arch or vault upon the abutments.

4. (*Shipbuilding.*) *a.* Drifts in the sheer draft are where the rails are cut off and ended with a scroll. Pieces fitted to form the drifts are called drift-pieces.

b. The difference in size between a treenail and its hole, or a hoop and the spar on which it is driven.

c. The part of the upper strake between the coach and the quarter-deck. *Drift-rail.*

5. (*Gunnery.*) A priming-iron to clean the vent of a piece of ordnance from burning particles after each discharge.

6. A stick used in charging rocket-cases.

7. (*Nautical.*) The direction of a current. The leeway of a ship.

Drift-an'chor. (*Nautical.*) A triangular frame of wood, or other similar contrivance, having just sufficient buoyancy to float, to which a line that leads from the bows of the ship is attached. It keeps the vessel's head to wind when dismasted, or when it is impossible to carry sail. See DRAG-ANCHOR.

Drift-bolt. A rod used to drive out a bolt.

Drift-net. A fishing-net about 120 feet long and 20 feet deep; corked at the upper edge. Several of these may be connected lengthwise and attached to a drift-rope. Meshes 2½ inches and upward, according to the size of fish.

Drift-piece. (*Shipbuilding.*) One of the upright or curved pieces of timber that connect the *plank-sheer* with the *gunwale.*

Drift-pin. A hand tool of metal driven into a hole to shape it; as the *drift* which makes the square socket in the watch-key. Holes in castings which are made by *cores* may be trued and trimmed in this way better, sometimes, than by drill or file. The tool is of steel, shaped to suit the work, and ground square on the face. See DRIFT.

Drift-sail. One dragging overboard to diminish leeway. A DRAG or DRAG-ANCHOR (which see).

Drift'way. (*Mining.*) A passage cut under the earth from shaft to shaft.

Drill. 1. A metallic tool for boring a hole in metal or hard material such as stone.

Its form varies with the material in which it works. The action in metal is usually rotative, and the tool has two or more cutting edges.

In stone drills the action is rotative or reciprocating; in the latter case the tool is alternately lifted and dropped. See ROCK-DRILL.

To drill a hole the Japanese have a short awl inserted in a round piece of stick eight or nine inches long. They take the wood between their toes, squat on the ground, and make the hole by rubbing the handle of the awl between their hands.

The bone needles of the ancient *tumuli* builders of Europe were drilled with stone drills; the eyes are small, round, and regular. The New-Zealanders, in the time of Captain Cook, were able to drill holes through glass with bone tools.

Of form of drills: —

a affords two views of the ordinary double-cutting drill used with a bow; the two edges forming the point meet at an angle of from 80° to 100°.

b is a drill for cast-iron with two circular chamfers.

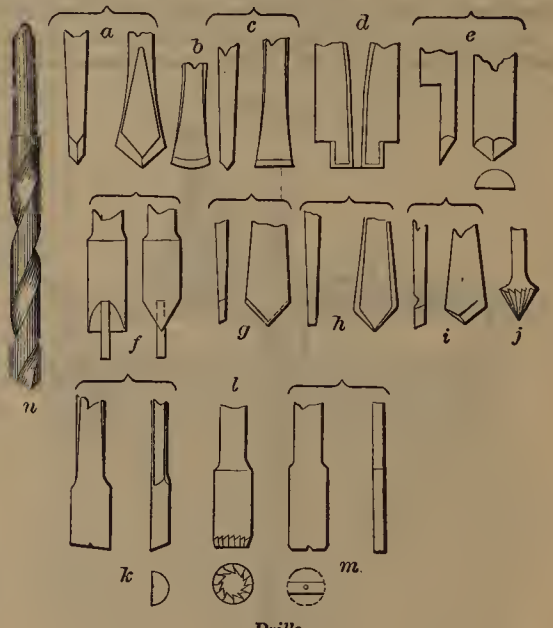
c is a flat-ended drill for flattening the bottoms of holes.

d is a duplex expanding drill for inlaying escutcheons on knife-handles, etc.

e is a drill formed of a cylindrical wire filed off to the diametric line and having two facets on the end.

f is a square countersink drill, having a guide-pin in the center.

Fig. 1766.



Drills.

g is a drill for cutting in one direction.

h, a drill for horn and other objects liable to agglutinate, and requiring great clearance.

i is the usual form of iron drill.

j is the cone countersink.

k is the half-round or cylinder lathe-bit.

l is the rose-bit for the lathe.

m is the flat-bit for the lathe.

n is the twist-drill.

See under the following list: —

Air-drill.
Archimedean-drill.
Bench-drill.
Bone-drill.
Boring-drill.
Bow-drill.
Brace-drill.
Breast-drill.
Burr-drill.
Cat-rake.
Center-drill.
Centrifugal-drill.
Cherry-drill.
Churn-drill.
Corner-drill.
Colter-drill.
Cramp-drill.
Dental-drill.
Diamond-drill.
Differential-feed drilling-machine.
Double-drill.
Drill.
Drill-barrow.
Drill-bit.
Drill-bow.
Drill-chuck.
Drill-extractor.
Drill-grinding machine.
Drill-gage.
Drill-harrow.
Drill-holder.
Drilling-jig.
Drilling-attachment for lathe.
Drilling-machine.
Drill-jar.
Drill-pin.
Drill-plow.
Drill-press.
Drill-rod.
Drill-rod grab.
Drill-spindle.
Drill-stock.
Drill-tongs.
Expanding-drill.
Fly-drill.
Grab-drill.
Grain-drill.
Hand-brace.
Hand-drill.
Pallette.
Persian-drill.
Piercer.
Pin-drill.
Pneumatic-drill.
Ratchet-drill.
Rock-drill.
Socket-drill.
Tapping-drill.

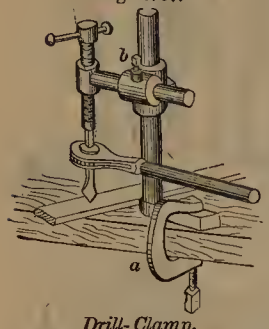
Tire-drill. Vertical-drill.
Traverse-drill. Well-drill.
Twist-drill. Wimble-drill.

2. A machine for sowing grain in rows. See GRAIN-DRILL.

3. (*Fabric.*) A heavy, cotton twilled goods, used especially for lining. *Drilling.*

Drill-clamp. A fastening device *a* for attaching a drill-holder or stock *b* to a work-bench.

Fig. 1767.



Drill-Clamp.

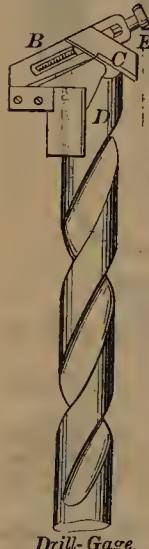
Drill-bar'row. A seeding-machine, driven by manual power in the manner of a wheelbarrow. A hand-driven grain-drill.

Drill-bow. The bow whereby the drill is reciprocally rotated. See BOW-DRILL.

Drill-chuck. A chuck in a lathe or drilling-machine for holding the shank of the drill. See CHUCK.

Drill-ex-tract'or. A tool or implement for extracting from deep borings a broken or a detached drill which interferes with farther boring. See ARTESIAN-WELL; WELL-BORING; GRAB.

Fig. 1768.

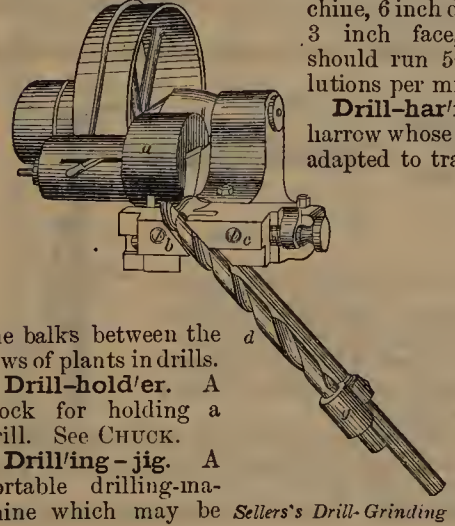


Drill-Gage.

Drill-gage. A tool for determining the angle of the basil or edge of a drill. In the example, the angular piece *C* slides by means of the thumb-screw *E* upon the part *B*, and the angle subtended by the two parts is the proper angle for the drill-point. The set-screw allows its adjustment to any sized drill.

Drill-grind'ing Ma-chine'. An emery-wheel *a* and a clamp consisting of a stationary part *b* and a movable part *c* by which the drill *d* is held near the point, while the shank is supported by the rod and extensible socket *g*. The machine is arranged to grind twist and fly drills, making cutting edges of uniform angle and length, thus insuring equality of cut upon both sides. Twist-drills up to 1 inch in diameter are held in the jaws of the clamp; split thimbles hold drills over 1 inch in diameter. Fast and loose pulleys on machine, 6 inch diameter, 3 inch face, which should run 500 revolutions per minute.

Fig. 1769.



Sellers's Drill-Grinding Machine.

Drill-har'row. A harrow whose teeth are adapted to traverse in the balks between the rows of plants in drills.

Drill-hold'er. A stock for holding a drill. See CHUCK.

Drill'ing-jig. A portable drilling-machine which may be dogged to the work, or so handled as to be readily presented to it and worked by hand.

Drill'ing-lathe. A drilling-machine on horizontal ways or shears, and thus resembling a lathe. See DRILLING-MACHINE.

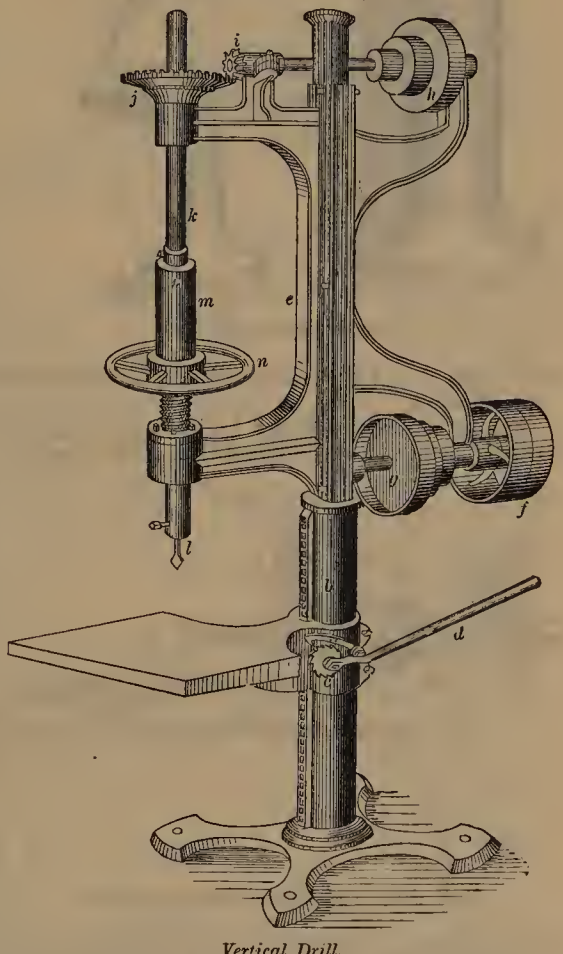
Drill'ing-ma-chine'. A machine carrying a rotating tool and a means for chucking the object to be bored. These machines differ greatly in size and appearance, in the mode of presenting the tool, presenting and chucking the work.

The larger machines are frequently known as *boring-machines* (which see).

Fig. 1770 has a vertical drill-stock *e* and vertical adjustment *d b c* to the bed-plate. The driving portions *h i j k l* and feeding devices *m n* are evident.

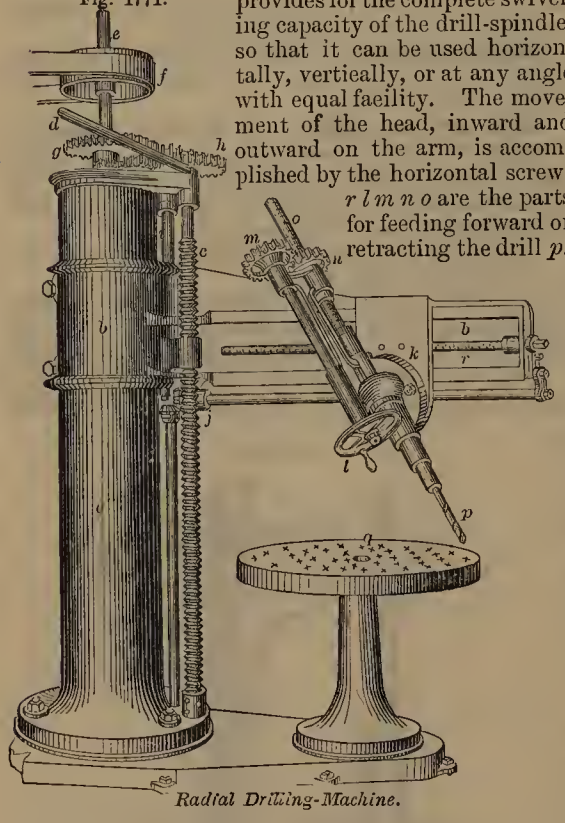
Fig. 1771 is a radial drilling-machine in which the tool, in addition to the horizontal and vertical adjustment of the overhung-beam *b*, has a circular adjustment of the drill-stock *o p* in a vertical plane, so as to present the tool obliquely to the work. The whole machine swings around a stationary post in the center of the hollow column *a*, and the overhung-beam is vertically adjustable on the latter by means of a screw *c*, actuated by power, brought into action by the lever *d* seen at the top of the column. As it is desirable that no belts should intervene to mar the complete revolving sweep of the machine, the driving is applied through the center direct by shaft *e*, pulley *f*, and gears *g h*, and transmitted to the upright shaft, whence the horizontal shaft carries it to the spindle by means of two pairs of miter-gears, one of which is shown at *j*. This arrangement also

Fig. 1770.



Vertical Drill.

Fig. 1771.



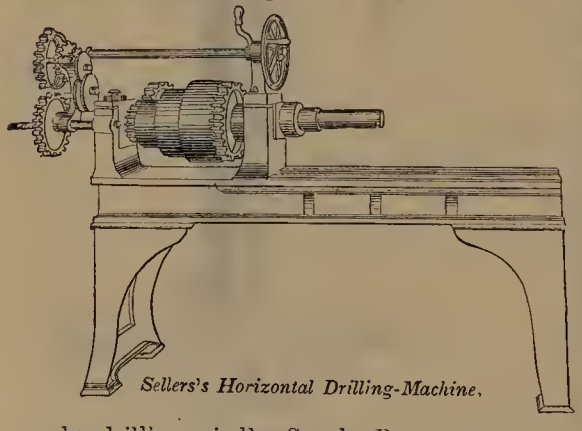
Radial Drilling-Machine.

provides for the complete swiveling capacity of the drill-spindle, so that it can be used horizontally, vertically, or at any angle with equal facility. The movement of the head, inward and outward on the arm, is accomplished by the horizontal screw. *r l m n o* are the parts for feeding forward or retracting the drill *p*.

The table *q* is for the convenience of the smaller class of work.

Fig. 1772 shows Sellers's horizontal drilling and boring machine for car-boxes, with self-acting variable

Fig. 1772.



Sellers's Horizontal Drilling-Machine.

speed to drilling-spindle. See also BORING-MACHINE.

Drill-jar. A form of stone or well-boring tool in which the tool-holder is lifted and dropped successively. The drill-rod is raised sufficiently between each impulse to loosen the tool from its impression in the stone, and is then dropped to give a blow to the tool. The tool-shank screws into the socket at the lower end of the piece *f'*.

Drill-pin. (*Locksmithing.*) The pin in a lock which enters the hollow stem of a key.

Drill-plate. A breast-plate for a hand-drill.

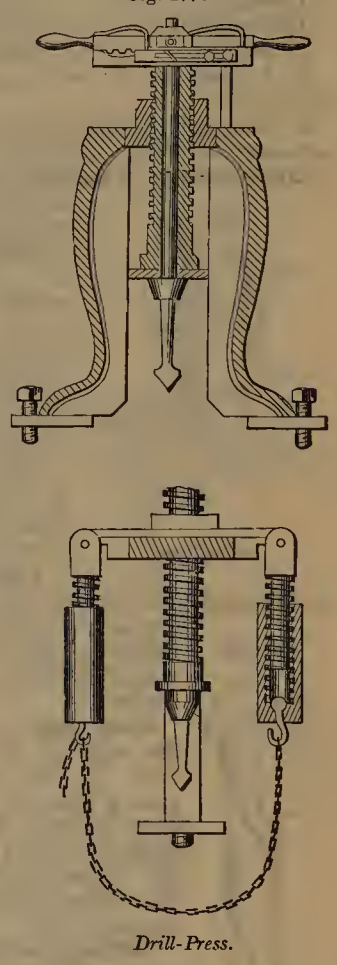
Drill-plow. A plow for sowing grain in drills.

Drill-press. 1. A drilling-machine in which a screw is made to feed the drill to its work. In the illustration, the press is shown in elevation and vertical section. It has feet for bench-work, and a

Fig. 1773.

Drill-Jar.

Fig. 1774



Drill-Press.

sling chain and adjustable sockets when used for tapping pipes.

2. A drilling-machine of large size. See DRILLING-MACHINE; BORING-MACHINE.

Drill-rod. The long rod, made of sections coupled together, which reaches to the surface of the ground and carries the well-boring tool on its lower end.

Drill-rod Grab. A clutching-tool lowered into a hole to engage with and form a means of withdrawing a drill-rod whose upper portion has been broken off or become detached.

Drill-spin'dle. The axis in which a drilling-tool is stocked and on which it rotates in a drilling-machine or lathe.

Drill-stock. *a.* A handle or holder for a drill, in

Fig. 1775.

Drill-Stock

which it is socketed, and by which it is worked. Fig. 1775, *a* shows the manner in which the reciprocation of the nut in the spiral grooves of the shank revolves the drill in a uniform direction.

b is a drill with a breast-plate and a stock rotated by bevel-gearing and crank. See RATCHET-DRILL; PERSIAN-DRILL, etc.

Drill-tongs. A tool in which one jaw forms a

bearing below the object, and the other carries the tool and rotative apparatus. The pressure is obtained by pressing the handles together, and an adjustable rest allows the purchase to accommodate itself to oblique surfaces.

Drip. The projecting edge of a molding or corona, channeled beneath.

Drip-joint. (*Plumbing.*) A mode of uniting two sheets of metal in roofing where the joint is *with* the *current*, so as to form a water conductor.

Fig. 1776.

Drip-Joint.

Drip'ping-vat. A tank beneath a boiler or hanging frame, to catch the overflow or drip, as that which receives the solution of indigo running from the boiler in indigo-factories.

Drip-pipe. A small copper pipe leading from the waste-steam pipe inside, to carry off the condensed steam and other hot water which may be blown into the "trap" at the top.

Drip-stick. (*Stone-sawing.*) A wooden stick which forms a spout to lead water slowly from a barrel to the stone, so as keep the kerf wet.

Drip-stone. 1. A corona or projecting tablet or molding over the heads of doorways, windows, arch-ways, niches, etc. Called also a *label; weather-molding; water-table; hood-molding.*

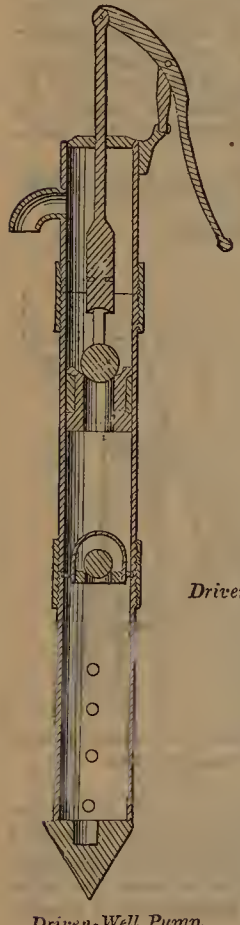
2. A porous stone for filtering.

Drive. (*Forging.*) A matrix formed by a steel *punch*, *die*, or *drift*.

Drive-bolt. A *drift*. A bolt for setting other bolts home, or depressing the heads below the general surface.

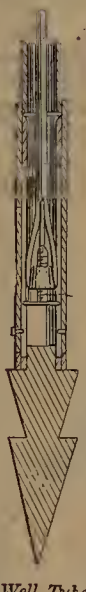
Driv'en-well. A well formed of a tube driven into the ground until its perforated end reaches a stratum containing water. When the tube is driven to the desired depth, the outer tube is elevated sufficiently to expose the slots of the tube, which is secured to the barbed point.

Fig. 1777.



Driven-Well Pump.

Fig. 1778.



Driven-Well Tube.

When the proper depth has been reached, a plunger is placed in the tube, which thus forms a pump-stock of limited bore.

Driv'en-well Pump. A pump of proportions and construction adapted to occupy a tube which has been driven into the ground till its lower end has reached a watery stratum.

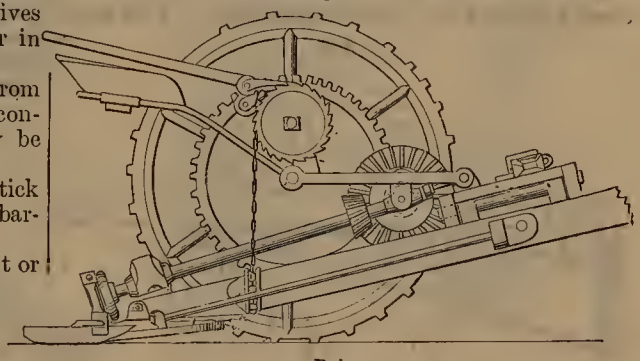
Drive-out. (*Printing.*) To space widely, to make a line of copy fill out the line, as when a mass of solid matter is divided into several *takes*, each being required to begin and end a line.

Driv'er. 1. (*Coopering.*) A tool used by coopers in driving on the hoops of casks, its tooth resting on the hoop.

2. (*Machinery.*) *a.* The wheel of a locomotive to which the power is communicated. A pair of drivers are arranged on an axle, their cranks or wrist-pins being at an angle of 90°, so that one is always in an advantageous position for duty, relatively to the piston. Several pairs of drivers are coupled together by connecting-rods.

b. In gearing, the main-wheel by which motion is imparted to a train of wheels. A *master-wheel*, as in the example, where the tread-wheel of the harvester is the agent in driving the miter-wheels and crank of the cutter-bar.

Fig. 1779.



Driver.

3. (*Milling.*) The term is applied to that which communicates motion, as the cross-bar on the spindle by which motion is communicated to the runner of a grinding-mill. A *peg*, *catch*, *tappet*.

4. (*Blasting.*) The copper bar by which the tamping is driven around the pricker on to the charge in a blast-hole. A *tamping-iron*.

5. (*Nautical.*) A four-cornered *fore-and-aft* sail, on the lower mast of a ship; its *head* is extended by a *gaff*, and its *foot* by a *boom* or *sheet*. A *spanker*.

A *ring-tail* is a sail added at the lee-leech of a driver.

6. (*Turning.*) A bent piece of iron fixed in the center-chuck, and projecting so as to meet the *carrier* or *dog* on the mandrel to which the work is attached.

7. (*Weaving.*) The piece of wood which impels the shuttle through the shed of the loom.

8. A drift for enlarging a hole or giving it an angular shape not attainable by a drill. See DRIFT.

9. A stamp or punch; the salient tool which acts in conjunction with the *bed*, *bottom*, or *bolster*, through whose aperture the excised piece of plate is driven.

10. (*Shipbuilding.*) The foremost spur in the bulge-ways, the heel of which is fayed to the fore-side of the foremost poppet, and the sides placed to look fore and aft in a ship.

Driv'ing-ax'le. (*Machinery.*) The axle of a driving-wheel; the bearing portion rests in the driving-box. The weight of that portion of the engine is supported by a *driving-spring* upon the *box*.

Driv'ing-bolt. A wheelwright's tool used for driving in nave-boxes.

Driv'ing-chis'el. A chisel basiled on each face.

Driv'ing-gear. That portion of a machine which is especially concerned in the motion; as the parts from the cylinder to the wheels, inclusive, of a locomotive; the ground-wheel to the cutter-bar pitman, inclusive, of a harvester; the hand-crank and gearing of a winch or crab, etc.

Driv'ing-rein. (*Saddlery.*) A rein which is buckled or snapped to the bit-rings and passes back

to the driver. Driving-reins are known in the West as *lines*.

Driv'ing-shaft. A shaft communicating motion from the motor to the machinery.

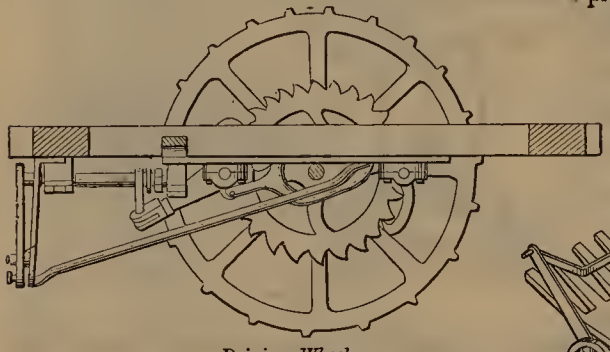
Shafting transmits power, but the *driving-shaft* is more immediate to the power; the motor.

Driv'ing-springs. The springs fixed upon the boxes of the driving-axle of a locomotive-engine, to support the weight and to deaden the shocks caused by irregularities in the rails.

Driv'ing-wheel. 1. (*Steam-engine.*) One of the large wheels of a locomotive to which the connecting-rods of the engine are attached.

In the American practice the connecting rod is usually coupled to a wrist on the driver. This may

Fig. 1780.



Driving-Wheel.

be coupled by outside connecting-rods to other wheels of the same size, so as to make *drivers* of the latter.

In the English practice, with cylinders inside of the frame, the connecting-rods are coupled to cranks on the axle of the drive-wheels.

2. (*Harvester.*) The wheel which rests upon the ground, and whose tractional adherence thereto, as the frame is dragged along by the team, is the means of moving the gearing and giving motion to the cutter and reel.

Drog. (*Nautical.*) A buoy attached to the end of a harpoon line.

Drogh'er. (*Nautical.*) A West India cargo-boat, employed in coasting, having long, light masts and lateen sails. *Droger.*

Droitzsch'ka. A Russian traveling-carriage. See DROSKY.

Drone. (*Music.*) The base-pipe of a *bagpipe* (which see).

Drop. 1. A machine for lowering loaded coal-cars from a high staith to the vessel, to avoid the breaking of the coal by dropping it from a hight. It is a perpendicular lift in which the car is received in a movable and counterpoised cradle which is lowered and returned. A falling leaf is projected outward, to bring the wagon over the hatchway of the vessel.

2. A swaging-hammer which drops between guides. See DROP-HAMMER.

3. (*Architecture.*) An ornament depending from the triglyphs of the Doric order, *gutta*.

4. A supplementary gas-tube to lower a gas-jet. See DROP-LIGHT.

5. A theatrical stage-curtain.

6. The depth of the hanger by which shafting is supported overhead.

7. A prismatic pendant for a chandelier, to increase the brilliancy of the display by the refraction of the rays of light. It is made of a glass lump molded in a *pinching-tongs*.

8. (*Nautical.*) The depth of a sail amidships.

9. (*Fortification.*) That part of the ditch sunk deeper than the rest, at the sides of a caponniere or in front of an embrasure.

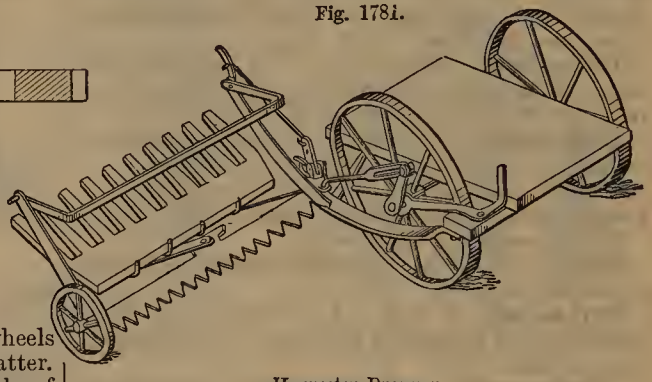
10. A falling trap-door, or hatch.

Drop-box. (*Weaving.*) A shuttle-box used in figure-weaving looms in which each shuttle carries its own color. The box is vertically adjustable by means of a pattern-chain or otherwise at the end of the shed, and, by automatic adjustment, the shuttle holding the required color is brought opposite to the shed and so as to be struck by the picker.

Drop'per. 1. One form of a reaping-machine in which the grain falls upon a slatted platform, which is *dropped* occasionally to deposit the gavel upon the ground. (Sieberling's patent.) Simultaneously with the bringing into action of the dropper, a cut-off is brought down to arrest the falling grain till the platform is reinstated.

(*Mining.*) 2. A divaricating vein, which leaves the

Fig. 1781.



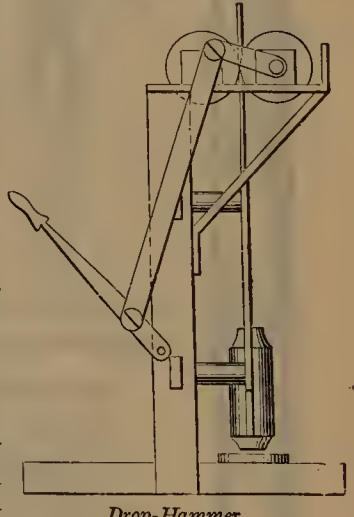
Harvester-Dropper.

main lode; or a lode which assumes a vertical direction.

Drop-flue Boil'er. One in which the caloric current descends by one or more steps or gradations, bringing it into contact with parts of the boiler in descending series; the object being to cause it to leave the boiler at the lower part, where the feed-water is introduced.

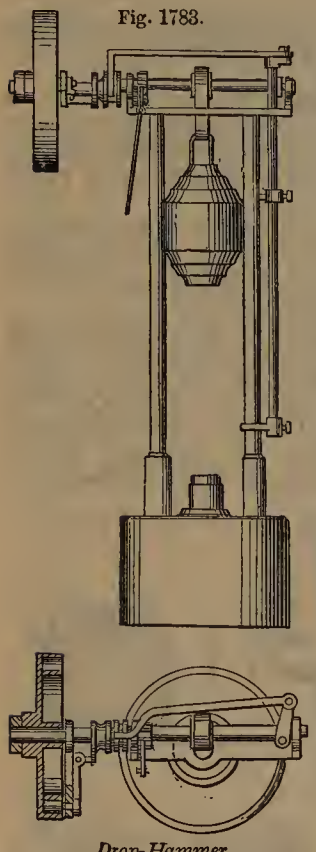
Drop-ham'mer. A hammer in which the weight is raised by a strap or similar device, and then released so as to drop upon the object below, which rests upon the anvil. It is used in swaging, die-work, striking up sheet-metal, jewelry, etc. In Fig. 1782 the hammer-strap is drawn upward by means of two pulleys, which are brought together so as to compress the strap between them. One of these, the driving-pulley, is fast upon its axle and turns in fixed bearings, while the other turns loosely upon an eccentrically journaled axis, arranged also in fixed bearings, but so as to be incapable of turning therein except as force is applied to it to effect that object. To one end of the latter shaft there is attached a horizontal arm, the outer end of which is connected to a hand-lever or treadle

Fig. 1782.



Drop-Hammer.

Fig. 1783.



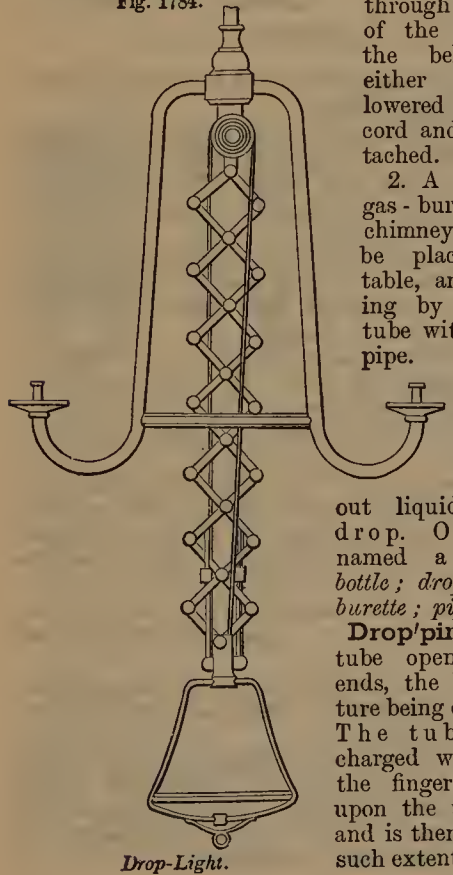
Drop-Hammer.

by a connecting-rod. By means of these appliances the eccentrically journaled shaft can be turned at will, so as to remove its roller from contact with the strap, and allow the hammer to fall through any length of space desired, within the limits of the machine.

In Fig. 1783, the hammer is raised by a strap which winds on to the main-shaft. By means of a clutch, the loose pulley is engaged with or disengaged from the driving-shaft, to raise the hammer or let it fall. An elliptical pin is journaled in an arm keyed to the shaft, and works in an annular groove in the side of the pulley. In one position of the pin it will bite between the walls of the groove and hold the pulley fast, and when turned on its axis it will release it.

Drop-light. 1. A means for placing the gas-burner at such elevation as may be convenient for reading or work, and supporting it in place without extraneous help. In Fig. 1784, a gas passage being formed through the arms of the lazy-tongs, the bell-light is either raised or lowered by the cord and pulley attached.

Fig. 1784.



Drop-Light.

2. A stand for a gas-burner and chimney, adapted to be placed on a table, and connecting by an elastic tube with the gas-pipe.

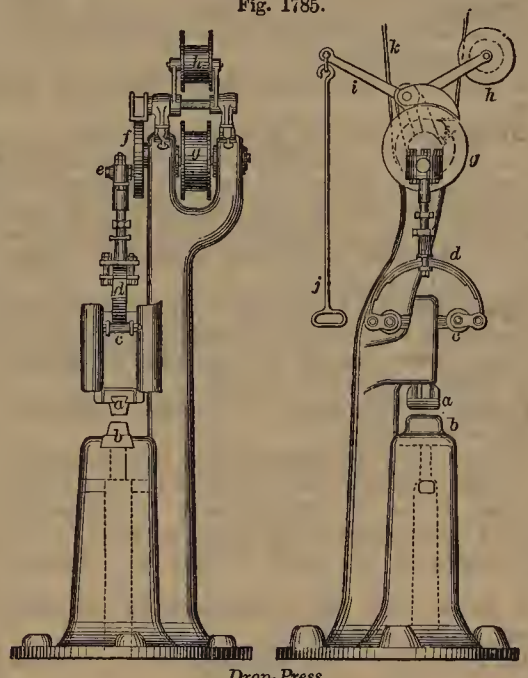
Drop-me'ter. An instrument for measuring out liquid drop by drop. Otherwise named a *dropping-bottle; dropping-tube; burette; pipette.*

Drop'ping-tube. A tube open at both ends, the lower aperture being quite small. The tube being charged with liquid, the finger is closed upon the upper end, and is then relaxed to such extent as to allow the liquid to exude in drops from the lower end. It is a small velinche.

The *dropping-bottle, pipette, burette,* and *drop-meter* have a similar purpose.

Drop-press. A form of power-hammer, not uncommonly called a press, and used for swaging as well as for ordinary forging. The machine represented has a hammer-block *a*, swung by a spring *d c* from a

Fig. 1785.



Drop-Press.

wrist on a disk *f*, which is rotated by the wheel *g* on its axis when the idler-pulley *h* tightens the band *k* against the wheel. This is done by pulling on the swinging rod *j i*, and, as soon as the rod is released and the idler falls back, the loose band runs over the wheel without rotating it. *b* is the anvil. See DROP-HAMMER; DEAD-STROKE HAMMER.

Drop-roll'er. (*Printing.*) A roller dropping at intervals to draw in a sheet of paper to the press.

Drop-ta'ble. A machine for lowering or raising weights, as in the hatchways and cellar-ways of city warehouses.

A machine for withdrawing car and locomotive wheels from their axles.

Dros'ky. A Sclavonic four-wheeled vehicle in which the passengers ride astraddle of a bench, their feet resting on bars near the ground. A *droitzschka.*

Dro-som'e-ter. An instrument for measuring the quantity of dew that collects on the surface of a body exposed to the open air during the night.

Weidler's instrument was a bent balance, which marked in grains the additional weight acquired by a piece of glass (or a pan) of certain dimensions, owing to the globules of dew adhering thereto; on the other end of the balance was a protected weight.

Another *drosometer* is substantially like a rain-gage.

Wells's drosometer was a tussock of wool weighed dry, and again after the accession of dew. Gideon on one occasion wrung out of a fleece "a bowl full of water" which was collected in this way.

Dross. The *scum, scoria,* slag, or recrement resulting from the melting of metals combined with extraneous matters.

Drove. 1. (*Masonry.*) *a.* A broad-edged chisel for stone-masons.

b. A mode of parallel tooling by perpendicular fluting on the faces of hard stones.

2. (*Hydraulic Engineering.*) A narrow irrigating channel.

Drowned-level. (*Mining.*) A depressed level or drainage-gallery in a mine, which acts on the principle of an inverted siphon. A *blind-level.*

Drown'ing-bridge. A sluice-gate for overflowing meadows.

Drug'get. (*Fabric.*) A coarse woolen fabric, felted or woven, self-colored or printed on one side; used to protect carpets.

A similar but finer article forms piano and table covers.

Drug-mill. One for grinding medicines; varying in size and construction according to the kind of drug and the resources of the establishment. The Chilian mill is used for some purposes; in the more usual form it has a rotating cone in a serrated case, like a coffee-mill, or adjacent disks, like a paint-mill. See GRINDING-MILL.

Drug-sift'er. A perforated tray or sieve either reciprocating or rotatory, inclosed in a casing, and having a drawer beneath for receiving the powder. It is usually operated by a crank.

Drum. 1. (*Machinery.*) A cylinder over which a belt or band passes.

When the cylinder bears a load, it becomes a *roller.*

A roller frequently has gudgeons to allow it to be dragged, as the *agricultural* and *garden* rollers. Such a roller (having gudgeons or axle), by the diminishing of its length sufficiently, becomes a *wheel.*

A narrow drum (*belt-bearing* cylinder) becomes a *sheave*, *pulley*, or *rigger.*

The *barrel* of a crane, windlass, winch, or capstan on which the rope or chain winds.

The *cylinder* on which wire winds, and whose rotation pulls it through the draw-plate.

The *grinding-cylinder* or *cone* of some mills, as the coffee or the plantation mill, etc.

2. (*Paper-making.*) A washing-drum for rags consists of a framework covered with wire gauze, in the interior of which, connected with the shaft or spindle, which is hollow, are two suction-tubes by which the water, after circulating through the rags, is carried away in a constant stream.

3. (*Calico-printing.*) One name of the cask in which steam is applied to printed fabrics in order to fix the colors. It consists of a hollow wooden cylinder with interior conveniences for suspending the cloths and covering them with flannel; after which the cover is applied and steam admitted for twenty or thirty minutes.

4. (*Architecture.*) The bell-formed portion of a Corinthian or composite capital.

5. (*Music.*) A musical instrument, formed by stretching parchment over the ends of a cylinder of wood or over a bowl-shaped metallic vessel. The skin of the ass is a very superior article for the purpose. If it were very sonorous, it would not be surprising. The Greeks used the bones of the ass for making flutes, so the animal has almost as great a compass in death as in life, which is saying a great deal. His range includes,

"The ear-piercing fife, the spirit-stirring drum."

The drum was a martial instrument among the ancient Egyptians, as the sculptures of Thebes testify. Their long drum (*a*) was like the Indian tam-tam, and was beaten by the hand. It was about 18 inches long, had a case of wood or metal, and heads of prepared skin, resembling parchment. These were braced by cords in a manner somewhat similar to the modern. The instrument was carried by a belt, and was slung behind the back on a march.

An instrument similar to the *darabooka* of modern Egypt is found represented in the tombs of Thebes. It consists of a parchment-head strained over a funnel-shaped body of pottery, and is played like a tambourine.

The cuts *c c* show a drum which was found in Thebes by D'Athanasi, and show how the strings were braced. The sticks *d*, accompanying, show that it was beaten in the modern manner.

The *derbekkeh* of modern Syria is similar to the Egyptian *darabooka*, as their names indicate. Much ornament is lavished upon the cases of the Syrian instruments, as may be seen in Thomson's "The Land and the Book." Oriental nations have very imperfect ideas of melody and harmony, but are very industrious players on the drum, castanets, and

Fig. 1786.

Drums.

tambourine, accompanied by the twanging of guitars and the clapping of hands.

The invention of the drum is ascribed to Bacchus, who, according to Polygœnus, gave his signal of battle by cymbal and drum. It was, however, known in very early ages, and in some form or other among almost all nations.

Drums of the barrel and kettle variety were used in Ancient Greece, and were beaten by hand and by sticks. The instrument came from Egypt, and passed from Greece to Rome.

After an interval, in which the classic civilization made a pause, the drum was re-imported into Europe by the Saracens about 713; its Arabic name, *altambor*, becoming *tambor* in Spain, *tambour* in France.

The native drums or *tam-tams* of the Asiatics are made of sonorous bronze with a skin covering, preferably a lizard skin, and are beaten by the hand. They are allied to the *darabooka* of Egypt and the Syrian drum.

The Chinese and Mandshu words for drum are onomatopoetic, and are respectively *kán-kán* and *tung-tung.*

The forms of drums among the Japanese are various,—kettle-drums, table-drums, tam-tams, suspended tambourines.

The drum of the Yucca Indians of Sonora is about 20 inches in diameter, and consists of a skin stretched on a wooden hoop. The skin is apparently that of a buffalo calf, and is tightened by cords. It has but one head, like a tambourine.

John Ziska, the Hussite, died of the plague, and before he expired ordered that his skin be made into the covering of a drum, to be beaten in the advance.

"His name shall beat the advance, like Ziska's drum."

This noted Pole fought the Emperor Sigismund, 1420–22. The latter had given a safe-conduct to John Huss, who was cited before the Council of Constance. Huss was abandoned by the Emperor to his enemies, and was burned by the Roman Catholics, July 6, 1415.

The modern drum *f* is a cylinder of brass or wood, over the ends of which parchment heads are stretched. The tension is obtained by a system of cords, and is regulated by sliding knots of leather. The head which is beaten is called the batter-head, and the opposite, across which two cords are stretched, the snare-head.

The *snare* drum has a catgut string stretched across its lower head to impart a certain quality.

The smaller drums are beaten with sticks. The larger, bass drum, is beaten with padded drum-sticks.

The large drum, beaten at both ends, is called a *double-drum*. Those hanging by the side of the drummer are called *side-drums*.

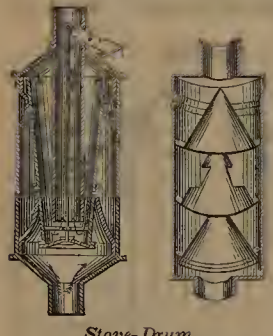
The kettle-drum *g* is so called from its resemblance to a hemispherical kettle. It is formed of thin copper, and has a head of parchment or vellum.

The small military drum is frequently called by this name. They are still used in pairs, in the English and Prussian armies and elsewhere, slung on each side of the withers of a cavalry horse. One drum was tuned to the key-note, and the other to the fifth of the key. The tuning is by a hoop and screws.

They are now usually supported upon a tripod and used in orchestras. The *tam-tam* is the original kettle-drum.

6. (*Mechanics.*) A chamber of a cylindrical form used in heaters, stoves, and flues. It is hollow and thin, and generally forms a mere casing, but in some cases, as steam-drums, is adapted to stand considerable pressure. The drums in Fig. 1787 are radiators, and the caloric current is compelled to follow a sinuous course through the drum.

Fig. 1787.



Stove-Drum.

7. A small cylindrical box for holding fruit. A keg with straight sides.

Drum-curb. A cylinder of wood or cast-iron inserted in a hole which forms the commencement of a shaft, to support a brick structure or shaft lining. The earth is dug away below the edge of the drum, and as the latter sinks the courses of brick are continually added at the top.

Drum Cyl'in-der-press. (*Printing.*) One having a large hollow cylinder. A feature in several forms of presses.

Drum-head. (*Nautical.*) The head of the capstan, having square holes to receive the bars.

Drum'mond Light. Invented by Lieutenant Drummond, Royal Engineers, during the progress of the Ordnance Survey in England, about 1826, to supply a deficiency which was found to exist in the means of making distant stations visible from each other. It is made by exposing a small ball of quicklime to the action of the oxy-hydrogen blow-pipe, or the lime may be placed in the flame of a spirit-lamp fed by a jet of pure oxygen gas.

Drummond's apparatus was so constructed that the lamp fed itself automatically with spirit and with oxygen, supplying itself with balls of lime as they were gradually consumed, and was provided with a parabolic silvered copper mirror. With this apparatus the light produced by a ball of lime not larger than a boy's marble, at Londonderry, was visible at Belfast, a distance of nearly seventy miles, in a direct line. Subsequently, Colonel Colby made a lime-light signal visible from Antrim, in Ireland, to Ben Lomond, in Scotland, a distance of ninety-five miles in a straight line.

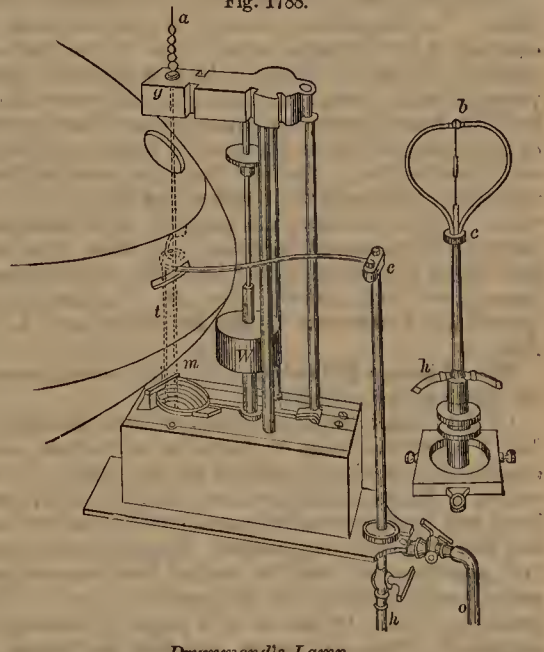
It is stated that, intensified by a parabolic reflector, it has been observed at a distance of 112 miles.

It is understood that the first application in practice was when it was required to see Leith Hill, in Surry, from Berkhampstead Tower, in Hertfordshire.

The practical application was described in two papers published in the "Philosophical Transactions of 1826 and 1831."

The apparatus consists of a lamp which admits oxygen and hydrogen gas at the respective apertures *o h*. The gases come from separate holders, and do not mix till they reach the chamber *c*. Here they pass through several thicknesses of wire-gauze,

Fig. 1788.



Drummond's Lamp.

which prevent explosion by the reflex action of the flame, and then issue at two points, being projected upon the ball *b*, which revolves once in a minute to prevent wasting at the two points where the flame impinges upon it. A ball of lime lasts about forty-five minutes, and a reserve of them is kept upon the wire *a m*, one being released periodically, and, falling upon the curved support *t*, is held in focal position, the former ball having dropped into the cistern below. *b* represents the focal ball in position; the ball at *g* falls into a position where it becomes gradually heated; at the end of that time the curved support *t*, moving on a pivot, is temporarily thrown out of its normal position by means of the weight *W*. The exhausted ball falls away, and a fresh ball falls into the focus. The wire *a b* passes

through the focus of the parabolic reflector, and holes are cut in the reflector for the passage of the balls and for the curved jet-pipes, which are pivoted to the stand-pipe.

Drum-saw. A cylindrical saw for sawing curved stuff, staves especially. A *cylinder-saw; barrel-saw.*

Drum-wheel. A very ancient Oriental form of water-raising wheel which was originally drum-shaped, but afterwards had scoop-shaped buckets which dipped up water and conducted it towards the axis, at or near which it was discharged. See TYMPANUM.

Drunk'en-cut'ter. An elliptical cutter-head, placed at such obliquity on the shaft as to revolve in a circular path. A *wabbler.*

Drux'ey. Timber in a state of decay, with white spongy veins.

Dry-arch. (*Building.*) An arch employed in the foundations of buildings for the purpose of keeping them dry.

Dry-cast'ing. The process of casting in which the molds are made from sand, and subsequently dried.

Dry-dock. A dock from which the water is withdrawn after the vessel has floated into it. Advantage is generally taken of the flow-tide to introduce the vessel, and of the ebb to withdraw the water. The water flows out by sluices, and the gates point outward to resist the re-entrance of the water. A *graving-dock.*

After the great ship of Ptolemy Philopator was afloat, "a Phœnician devised a new method of docking it by digging a trench close to the harbor, equal to the ship in length. In this trench he built props of solid stone, 5 cubits high, and across them he laid beams crosswise running the whole width of the trench at four cubits distance from each other; and then making a channel from the sea he filled the excavated space with water and floated in the vessel. Then reclosing the entrance, he drained the water off by means of engines; and when this had been done the vessel rested securely on the cross-beams." — CALLIXENUS'S *Account of Alexandria,* quoted by ATHENÆUS in his *Deipnosophists,* A. D. 220.

This ship was 200 cubits long; 38 cubits beam; 48 cubits midship-hight.

Of the United States dry-docks at South Brooklyn, No. 1 is 500 feet long, 60 feet wide at bottom, and capable of receiving vessels of 12 feet draft at low water, or 18 feet at high water. No. 2 is 447 feet long, and receives vessels drawing 17 feet at low water, and 22 feet at high water. By means of a central gate this dock may be divided into two separate parts, each forming an independent dock. The pumping is done by means of a superior horizontal engine of 100-horse power, and two oscillators of 50-horse power and 30-horse power respectively. The former of these engines connects with a double centrifugal pump of mammoth proportions, and with a capacity for pumping and discharging 40,000 gallons of water per minute. At this rate the average time required for completely relieving the docks from water is about three and a half hours; the docks when full contain 8,000,000 gallons of water. The oscillators are attached to centrifugal pumps used for drainage, or keeping the docks free from water when occupied by vessels. Their average capacity is about 1,000 gallons each per minute.

Dry'er. A machine or apparatus for evaporating, driving off superfluous moisture, desiccating. The term is applied to a certain class of machines, and yet no absolute line can be drawn between it and ovens, kilns, etc. See: —

Bagasse-dryer.	Malt-dryer.
Barrel-dryer.	Manure-desiccator.
Cloth-dryer.	Oast.
Feather-renovator.	Offal-dryer.
Fruit-dryer.	Oven.
Grain-dryer.	Paper-dryer.
Kiln.	Wool-dryer.
Lumber-dryer.	

1. The heated tables or cylinders which expel the moisture from the just-formed paper, in the machine.

2. The oven which evaporates the moisture from ceramic work, giving the pieces a certain degree of rigidity and desiccation, when they are fit for the subsequent operations, according to their purpose and quality. See POTTERY.

3. An oven for drying fruit.

4. A kiln or heated cylinder for drying grain.

5. A closet for drying clothes or cloth.

6. A *core* stove.

7. In painting, a preparation to increase the drying and hardening properties of paint.

a. Litharge ground to a paste with drying oil.

b. White copperas, or sugar of lead, and drying oil.

Dry-gild'ing. A mode of gilding, by steeping linen rags in a solution of gold, burning the rags, and then with a piece of rag dipped in salt-water rubbing the ashes over the silver intended to be gilt.

The method was invented in Germany, and is first described in England in the "Philosophical Transactions" for 1698.

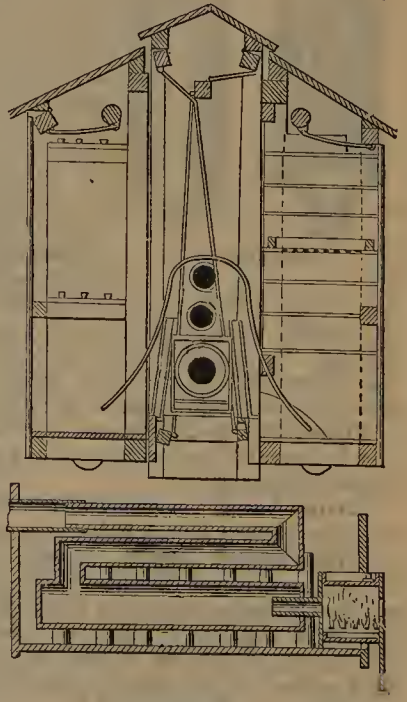
Dry-grind'ing. The cutler's mode of sharpening and polishing steel goods on a grindstone, without water.

It is very injurious to the health. Two remedies, or rather protections, are afforded: 1. ABRAHAM'S *magnetic-respirator,* which arrests the particles of steel. See RESPIRATOR. 2. Exposure of but a small portion of the stone, and a tube in the immediate vicinity of the work to carry off all the dust.

Dry'ing. The exposure of crystallizing magma sirup in a centrifugal machine, where the molasses is drained from it by mechanical action. See CENTRIFUGAL-MACHINE.

Dry'ing-house. An apartment in which anything is exposed to a current of air moderately heated; it is not easy to draw the line between an oven, a dryer, and a kiln: the words are used with some degree of carelessness, and have become technical in trades. Cores are dried in *ovens;* pottery in *ovens* or *biscuit-kilns;* fruit, lumber, and wool in *dryers;* grain in *dryers* or *kilns;* malt in *oasts;* clothes in *hot-*

Fig. 1789.

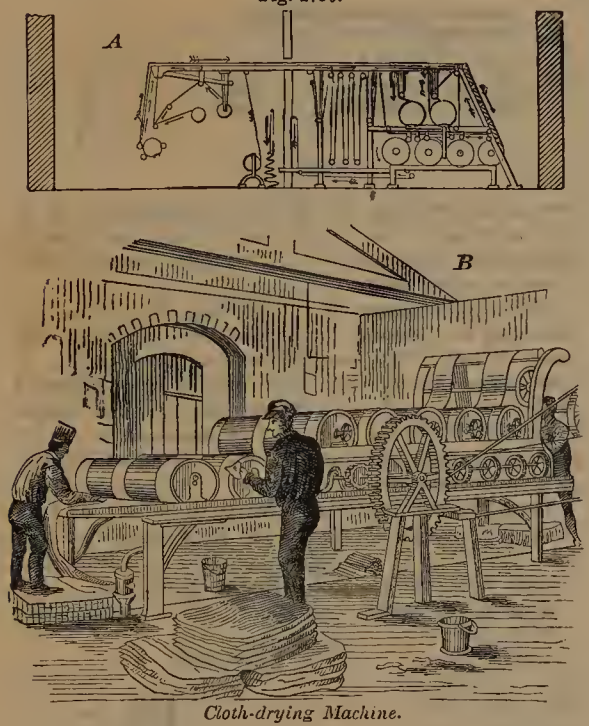


Drying-House.

closets; feathers in *renovators.* The illustration shows a dryer which has a drying-chamber comprising a central chamber and one or more wings hinged thereto, and mounted on wheels or casters for the purpose of ready access to the chambers and for removal from place to place. On one side is a suitable provision for drying clothes, and on the other for drying fruits. In the central chamber is a stove and apparatus for heating.

Dry'ing-ma-chine'. The machine for drying printed calicoes is shown by a vertical longitudinal section at *A*, Fig. 1790. The apparatus is in a hot room, and has a series of heated steam chests and cyl-

Fig. 1790.



Cloth-drying Machine.

inders with upper and lower rollers, over which the cloth is exposed to the drying air of the apartment. The arrows indicate the course of the cloth.

B, Fig. 1790, is a perspective view showing a series of heated cylinders upon which starched cotton or linen cloth is successively wound, drying and ironing it.

Similar drying cylinders are used in paper-making machines, both the cylinder machines and those of the Fourdrinier pattern, in which the sheet of pulp is felted on an agitated horizontal web.

Dry'ing Off. The operation in gilding by which the amalgam of gold is evaporated.

Dry'ing-room. The apartment in which articles or materials are dried; as, gunpowder, calico, cores, and what-not. Sometimes a kiln.

Dry'ing-stove. A place where cores for casting are dried.

A stove for desiccating fruit, drying clothes, etc.

Dry-me'ter. A form of gas-meter in which no liquid is used. See GAS-METER.

Dry-pile. A voltaic battery in which the plates are separated by layers of farinaceous paste combined with a deliquescent salt. Known as De Luc's Column.

Dry-pipe. (*Steam-engineering.*) A pipe which conducts dry steam from the boiler. The steam is collected in such a manner as to be free from priming.

Dry-point. (*Engraving.*) The work of an etching-point upon a plate, unaccompanied with the use of acid, to deepen the line so made.

Dry-press. (*Printing.*) One in which the printed sheets are pressed smooth.

Dry-sand. (*Casting.*) A mixture of sand and loam which are employed in making molds subsequently dried in an oven.

Dry-stove. A hot-house whose atmosphere is adapted hygrometrically for preserving the plants of arid climates.

Du'al-ine. Carl Ditmar's patent, No. 98,854, January 18, 1870. The composition is:—

Nitro-glycerine . . .	50 per cent.
Fine sawdust . . .	30 "
Nitrate of potasssa . .	20 "

Compared with dynamite, it is, 1. More sensitive to heat, and also to mechanical disturbances, especially when frozen, when it may even be exploded by friction; 2. The sawdust in it has little affinity for the nitro-glycerine, and at best will hold but 40 to 50 per cent of nitro-glycerine, and on this account very strong wrappers are needed for the cartridges; 3. Its specific gravity is 1.02, which is 50 per cent less than that of dynamite, and as nitro-glycerine has the same explosive power in each, its explosive power is 50 per cent less than that of dynamite; [bulk for bulk ?] 4. The gases from explosions, in consequence of the dualine containing an excess of carbon, contain carbonic oxide, and other noxious gases. Lithofracteur and dualine, however, can be exploded, when frozen, by means of an ordinary fulminating cap, which is not the case with dynamite. — *Journal of Applied Chemistry.*

Dub'bing. 1. (*Leather Manufacture.*) A mixture of fish-oil and tallow which is used to protect leather against the action of water. It is rubbed into the hide after currying, and is also freely used upon the hose of fire-engines and the boots of persons exposed to wet. *Daubing.*

Another recipe: Resin, 2 pounds; tallow, 1 pound; train-oil, 1 gallon.

2. (*Plastering.*) Filling up with coarse stuff irregularities in the face of a wall previous to finishing it by plaster.

3. Dressing off smooth with an adze.

Dub'bing-out. (*Plastering.*) A system of bringing an uneven surface to a plane by attaching pieces of tile, slate, lath, or other matters, to the wall beneath.

A projection may be made on a wall by the same means; pieces being attached to the wall and covered with plaster brought to shape by the trowel.

Dub'bing-tool. An instrument for paring down to an even surface. An *adze.*

Du-cape'. (*Fabric.*) A rich silk.

Duck. (*Fabric.*) A flax fabric lighter and finer than canvas.

Duck's-bill Bit. A wood-boring tool adapted to be used in a brace.

It has no lip, but the screw-cylinder which forms the barrel of the tool terminates in a rounded portion whose edge is sharpened to form the cutter. See BIT; BORING.

Duck's-foot Pro-pel'ler. A collapsing and expanding propeller which offers but little resistance in the non-effective motion, but expands to its full breadth in delivering the effective stroke, forming a kind of folding oar which opens to act against the water when pushed outward, and closes when drawn back at the end of the stroke.

The idea was taken from the foot of a duck, and was first tried by the celebrated Bernoulli, afterwards by Genevois, a Swiss clergyman, about 1757; then by Earl Stanhope about 1803. It was used on the river Thames about 1830.

NAIRN'S *propelling apparatus*, English patent, 1828, has the contractile retreat and expanding advance, the *advance* being understood to mean the effective stroke.

Duc'ti-lim'e-ter. An instrument invented by M. Regnier for ascertaining the relative ductility of metals. The metal to be tested is subjected to the action of blows from a mass of iron of given weight attached to a lever, and the effect produced is shown upon a graduated arc.

Duc-til'i-ty. The quality of adaptedness for drawing into wire; as malleability is for being beaten into leaves.

The order of metals in these two respects is as follows: —

Ductility.	Malleability.
Gold.	Gold.
Silver.	Silver.
Platinum.	Copper.
Iron.	Tin.
Copper.	Platinum.
Zinc.	Lead.
Tin.	Zinc.
Lead.	Iron.
Nickel.	Nickel.

Duc'tor. A gage or straight-edge to remove superfluous material, as one on the color-roller of a calico-printing machine, inking-rollers, etc. See DOCTOR.

Duc'tor-roll'er. (*Printing.*) A roller to conduct ink to another roller or cylinder.

Duf'fels. (*Fabric.*) A thick, coarse kind of woolen cloth having a thick nap or frieze.

Dug-out. A canoe formed of a single log hollowed out, or of parts of two logs thus hollowed out and afterwards joined together at the bottom and ends. See CANOE.

Dul'ci-an'a. (*Music.*) A metallic mouth-pipe stop tuned in unison with *diapason*, and having relatively long and narrow pipes which produce a certain sweetness of tone. See STOP.

Dul'ci-mer. The dulcimer is supposed to be identical with the psaltery of the Hebrews. It is frequently mentioned in Scripture. The modern *dulcimer* consists of a box with a cover which forms a sounding-board, and has a number of wire strings stretched over a bridge at each end. It is played by elastic rods with pellets of cork at the ends. The number of strings is usually about fifty.

"Here [at the puppet play in Covent Garden], among the fiddlers, I first saw a dulcimere played on with sticks knocking of the strings, and is very pretty." — PEPYS's *Diary*, May 24, 1662.

"The Javanese *gambang* has wooden and brass bars of different lengths placed crosswise over a wooden trough. They are struck by small sticks with a ball of pith at the end." — BICKMORE's *Travels in the Indian Archipelago.*

Du'ledge. The dowel-pins of the fellies of a gun-carriage wheel.

Dum. (*Mining.*) A frame of wood like the jambs of a door, set in loose ground in adits and places that are weak and liable to fall in or tumble down.

Dumb-bell. An exercising weight consisting of a handle with an oblate sphere at each end.

a is the ordinary dumb-bell.

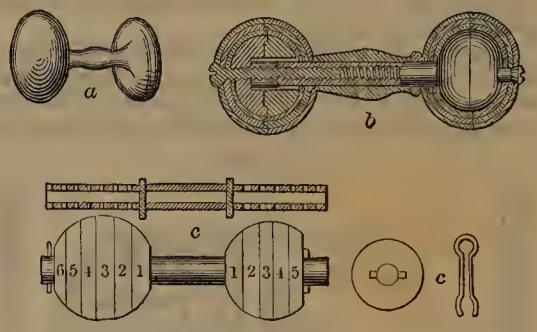
b is a dumb-bell in which the weight is graduated by constructing it of a series of shells, one over the other, which may be removed at pleasure.

c is Windship's dumb-bell, which has a number of weights slipping on a tube, and having washers and keys to hold firmly any number that may be desired.

The *halteres* of the Romans and Greeks were weights used for exercising and leaping. One was grasped in each hand and they were swayed to increase the momentum of the body when vaulting.

The *discus* was a circular stone or plate of metal, and was thrown from a fixed spot to a distance.

Fig. 1791.



Dumb-Bells.

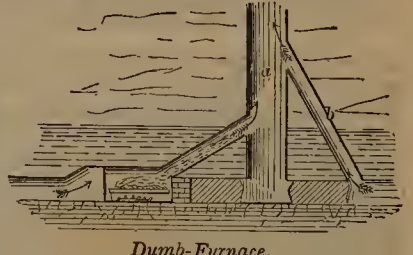
Our *quoits* are rings which are thrown on to or as near as possible to a stake, being a game of skill rather than of strength. In country places horse-shoes are often used.

The Scotch game of "putting the stone," or throwing the hammer, resembles the hurling of the lump of iron in the funeral games of the Greeks. A heavy mass of a spherical form (*solos*) was perforated at the center to receive a thong or rope which formed the handle. In the form of the *discobolia* it is yet used by the mountaineers in the canton of Appenzell, in Switzerland.

In the Scotch game of *curling*, the stone or iron block is propelled along the ice to a stake or base, called the "pee," the object being to land it as near "home" as possible and dislodge opponents.

Dumb-fur'nace. A ventilating furnace for mines, so contrived that the foul inflammable air from the more remote parts of the mine shall not be brought in contact with the fire at the mouth of the up-cast shaft *a*. This is effected by causing the air from those parts to be introduced into the shaft by a separate passage *b* entering the shaft some distance above that from the furnace.

Fig. 1792.



Dumb-Furnace.

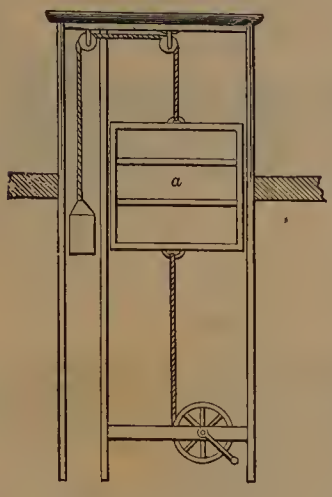
Dumb-plate. (*Steam.*) The *dead-plate* or portion of the furnace bottom close to the doors, which has no air apertures or spaces.

Dumb-wait'er. A movable frame for conveying food, etc., from one story or room of a building to another.

The ordinary form is a suspended, counterpoised cupboard *a*, moving within a vertical chute, which has openings at the respective stories, at which the dishes may be placed on the shelves and removed therefrom.

The dumb-waiter of the Pentonville Prison, England, consists of a cupboard *b* hoisted by means of a winch, and containing trays which are removed from the cupboard and placed on a carriage *c* which runs on the hand-railing *d* of the balconies on opposite sides of the corridor. This prison is conducted on the separate, silent system, and as the carriage trav-

Fig. 1793.



erses along the corridor, attendants at each end stop the carriage opposite the doors of the cells in succession, and distribute the food to the inmates.

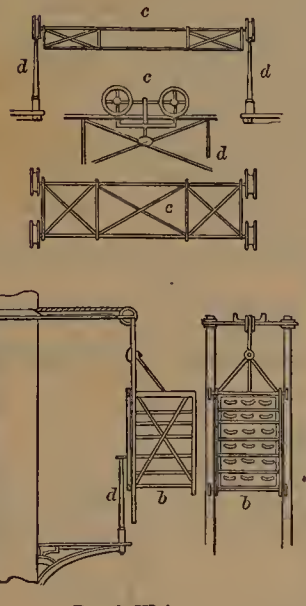
Dum'my. 1. A locomotive with condensing engines for city travel, and consequently avoiding the noise of escaping steam. See STREET-LOCOMOTIVE.

2. A floating barge connected with a pier.

3. (*Hat-making.*) A tool of box-wood, shaped like a smoothing-iron, and used by hat-makers in glossing the surface of silk hats.

Dum'my-car. A passenger-car having an engine and boiler in an end compartment.

Dumb-sin'gles. Silk thread formed of several spun filaments, associated and twisted together. Several *dumb-singles* combined and twisted together form *thrown-singles.*



Dumb-Waiters.

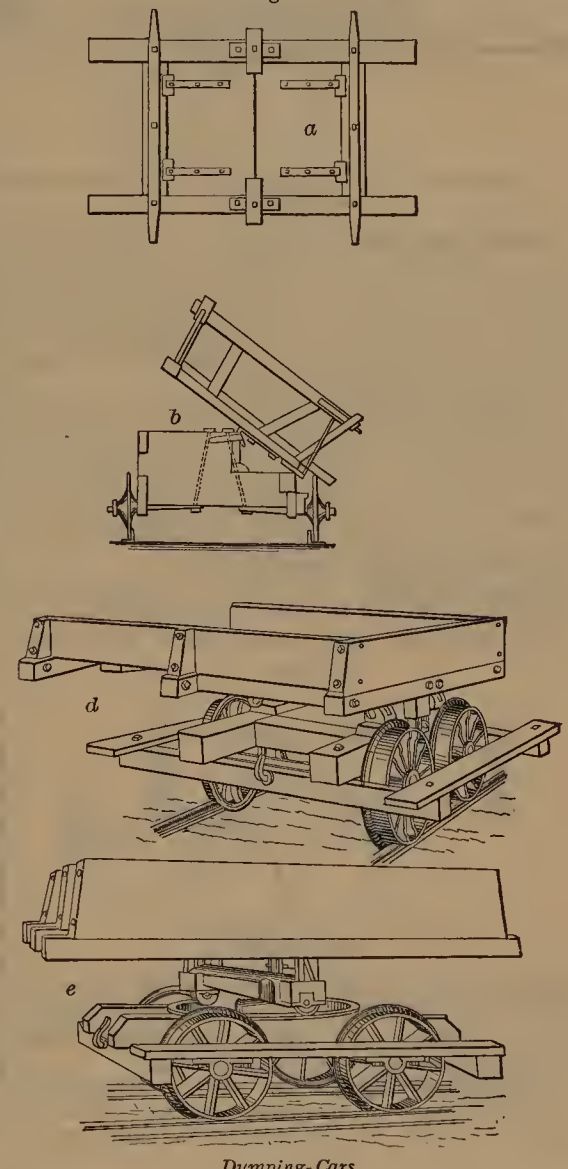
Dump-bolt. (*Shipbuilding.*) A short bolt driven in to hold planks temporarily, until the through bolts are driven.

Dump'ing-buck'et. (*Mining.*) A hoisting-bucket in a shaft so swung as to be tipped for the discharge of its load, or having a bottom which is closed by a latch, but may be swung open for dropping the contents.

Dump'ing-car. Dumping-cars are used in constructing and ballasting railroads, excavating and filling in, canal and dock building, for carrying ores, etc.

The car *a* has shutters in the bottom which are allowed to fall when a bolt or button is withdrawn. The tilting car *b* has a bed secured by a longitudinal bolt to the frame, and may be tilted sideways so as

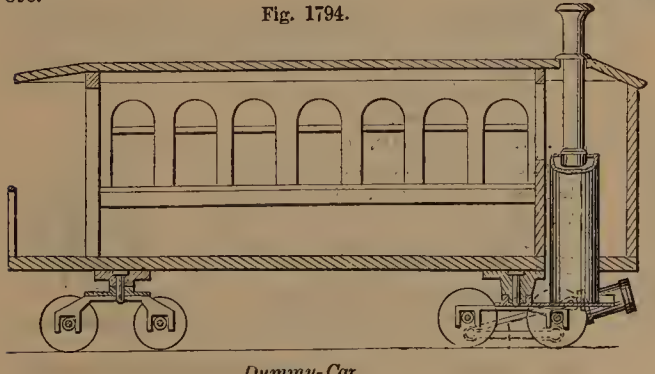
Fig. 1795.



Dumping-Cars.

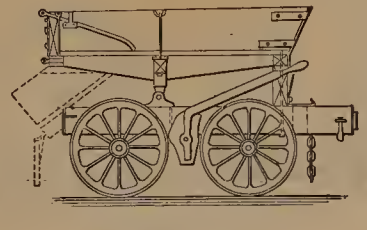
to discharge its load over the wheels outside the track. Hooks retain the bed in a level position till the car reaches the place to dump the gravel. Dumping-cars are made to discharge at end or side (*d*), or to swivel and dump in any direction (*e*). The load is about 2½ cubic yards.

Fig. 1794.



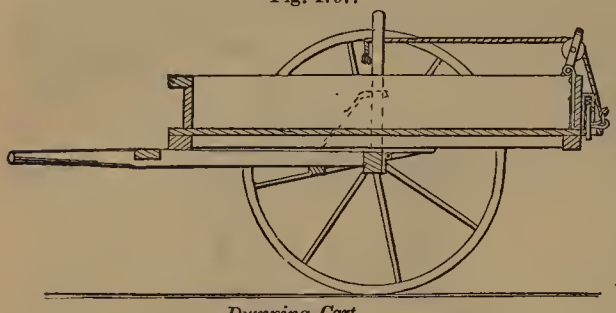
Dummy-Car.

Fig. 1796.



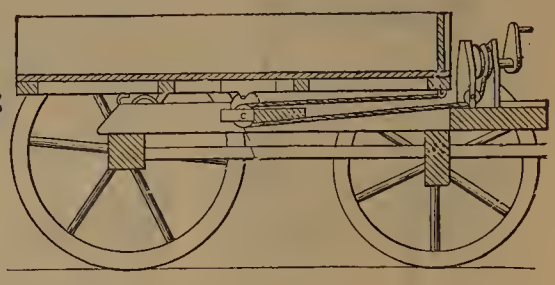
English Dumping-Car.

Fig. 1797.



Dumping-Cart.

Fig. 1800.



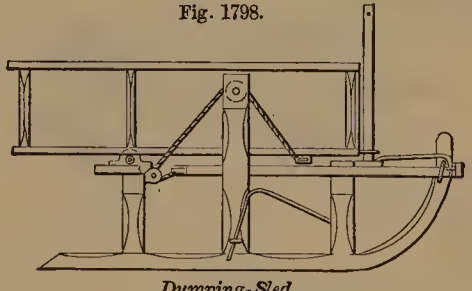
Gravel-Wagon.

Dump'ing-cart. One having a bed hinged to the axle and capable of being tipped to discharge its load. In the example, as the cart or wagon body is tipped up to dump the load, the tail-board will be raised automatically, and will drop back again into place and fasten itself as the said body is again raised into a horizontal position.

Dump'ing-reel. An arrangement in a harvester for dropping the gavels of grain. The cut grain falls against one of the reel-bars, which hold it up till a gavel is collected. The reel then makes a partial rotation, dropping what has been collected in the rear of the cutter-bar, and bringing another bar into position for collecting another gavel.

Dump'ing-sled. One with an arrangement for sliding back the bed so that it may overbalance and tip out the load. The box is hinged to the rear

Fig. 1798.

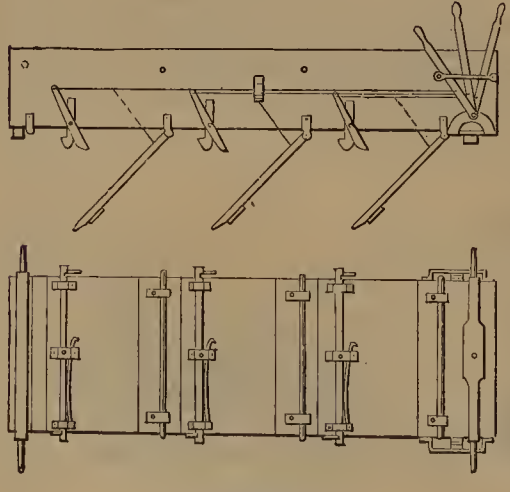


Dumping-Sled.

bolster so as to tip and dump the contents when the bed is run back. This is done by removing a catch, when the draft of the team on the tongue draws upon a rope and runs the box to the rear.

Dump'ing-wag'on. One with an arrangement for discharging the contents. In Fig. 1799 the hinged sections constituting the bottom may be

Fig. 1799.



Dumping-Wagon.

swung down to dump the load. Each section is independently held by a latch, and each latch may be operated by its appropriate lever at the right hand of the driver, so as to deposit the contents of the wagon-bed in three separate piles.

Fig. 1800 has a wagon-bed which runs back on rollers by power applied through a winch and ropes. By a change of the tackle the bed is replaced.

Dump'y-lev'el. Gravatt's level. A spirit-level having a short telescope with a large aperture, and a compass; used for surveying purposes.

The telescope is made of sufficient power to enable the surveyor to read the graduations on the staff without depending on an assistant.

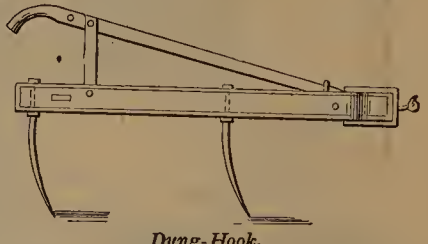
Dun'der. (*Sugar-making.*) The distillable lees and dregs of the cane-sugar boiling.

Dung-bath. Used in calico-printing works. See DUNGING.

Dung-fork. A 4-tined fork for pitching and spreading manure.

Dung-hook. (*Agriculture.*) An implement for dragging out manure or scattering that which has been previously dumped in heaps.

Fig. 1801.



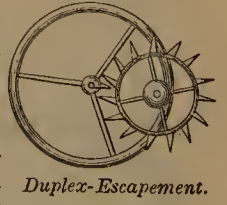
Dung-Hook.

Dung'ing. (*Calico-printing.*) Removal of the superfluous mordant by passing dried calico through a warm mixture of cow-dung and water. It is passed through two cisterns 6 feet by 3 and 4 feet deep, the first of which has two gallons of dung to its contents of water, and the other a solution of half the strength. It is quickly passed through them in succession, washed in a *wince-pit*, and then in a *dash-wheel*.

A solution of phosphate of lime, phosphate of soda, and gelatine, is sometimes substituted for the cow-dung.

Dun'nage. (*Nautical.*) On shipboard, the name applied to loose wood at the bottom of a hold to raise the cargo above the bilge-water, and also to chock it and keep it from rolling when stowed.

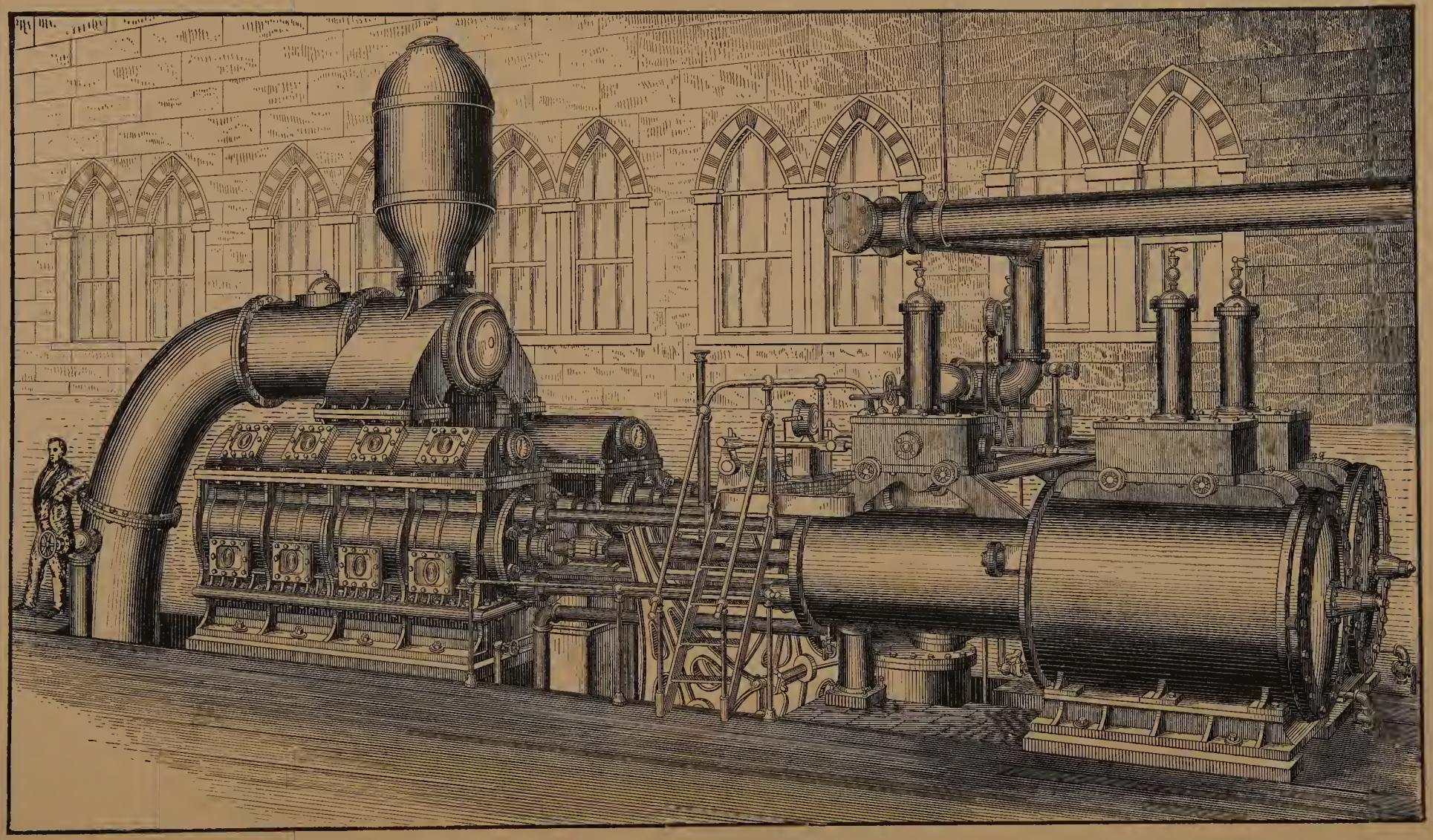
Fig. 1802.



Duplex-Escapement.

Du'o-dec'i-mo. (*Printing.*) A sheet folded so as to have 12 leaves, — 24 pages. Generally written "12mo."

Du'plex-es-cape'ment. The *duplex*-escapement is so called from the double character of its scape-wheel, which has *spur* and *crown* teeth. It was invented by that wonderful mechanician, Dr.



WORTHINGTON DUPLEX PUMPING-ENGINE.

NEWARK, NEW JERSEY.

PLATE XV.

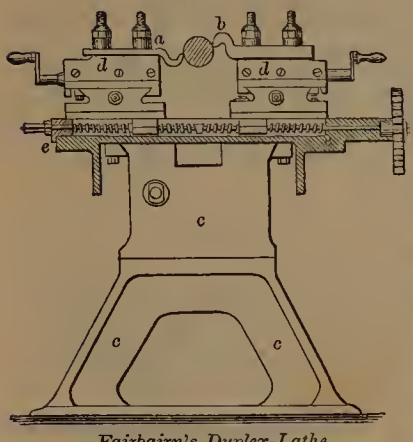
See page 763.

Hooke, about 1658. The duplex-escapement was improved by Dyrer and Breguet.

The *balance-arbor* carries a *pallet* which at each oscillation receives an impulse from the *crown-teeth*. In the *arbor* is a notch into which the *spur-teeth* fall in succession as the *crown-teeth* consecutively pass the *impulse-pallet*.

Du'plex-lathe. A lathe invented by Fairbairn for turning-off, screwing, and surfacing. The peculiarity in this lathe consists in the employment of a cutting-tool at the back of the lathe in addition and opposite to the tool in front, but in inverted positions to each other. The transverse forces are thus balanced, and time is saved.

Fig. 1803.



Fairbairn's Duplex-Lathe.

a, tool in front.

b, inverted tool at back.

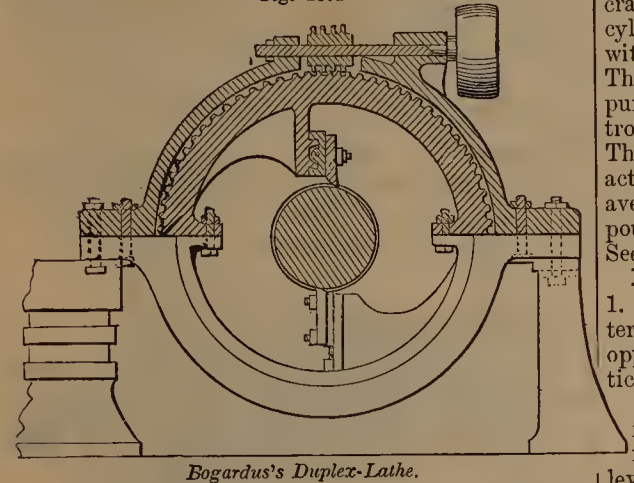
c, bed and standard.

d and *d*, two compound slide-rests.

e, a right and left screw for moving the two slide-rests simultaneously to and from the center of the lathe.

In another form the stationary ring is supported on pedestals, and fits closely to the outer surface of a ring within it, each being formed in two parts held together by bolts passing through projecting flanges. The inner ring has flanges projecting inward from its rim, upon which the cutters are arranged, and a continuous row of short cogs on the outer surface of the ring-gear, with a worm-wheel working in a mortise made through the outer ring.

Fig. 1804.



Bogardus's Duplex-Lathe.

Du'plex Pump'ing-en'gine. An arrangement in which two steam-engines of equal dimensions are placed side by side, one operating the steam-valves of the other.

The "Worthington" compound engine illustrated is composed of two steam-engines each working a pump. Each engine has two steam-pistons, which operate in the smaller high-pressure and the larger low-pressure cylinder respectively, on the same rod, which is prolonged into the pump-cylinder to form the pump-rod.

Each engine drives its plunger at a speed uniform throughout its stroke, during which it opens, by a rock-shaft and appropriate connections, the steam-valve of its neighbor, and pauses at the end of its own stroke till its own steam-valve, being opened by the motion of the other's piston-rod, causes it to return. Other than this, there is no mechanical connection between the engines, but either piston can remain at rest while the other is in motion.

The combined and reciprocal action of the two double-acting plungers thus driven at unvarying piston speed by the combined pressures in the high and low pressure steam-cylinders (whose sum is a practically uniform quantity) forces the water in a steady stream, and the water-valves are seated by their own gravity through the equalization of pressures in the water-cylinder, during the pause of each engine at the end of its stroke, allowing the incoming currents to subside.

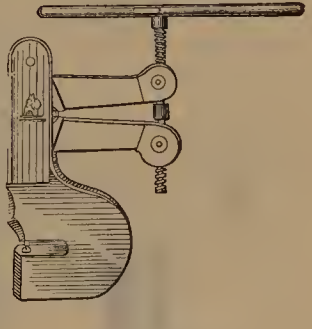
The engine works expansively, and also condenses the steam; but no cut-off is used, the steam being used at high pressure in the smaller cylinder and exhausting into the large low-pressure cylinder which is immediately behind and in line with it, and where it is used expansively. The motions are all reciprocating; no materials are employed for counterbalances, to pass dead-centers, or as conservators of power (fly-wheels) to offset by acquired momentum the diminishing pressure of steam in the cylinder when steam is cut off at a part of the stroke. The mean pressure resulting from the action of the two cylinders being almost constant when the parts are properly proportioned, the result is a uniform piston speed.

The single-acting air-pumps are driven by rock-shafts off the main piston-rod, and are in a convenient and accessible position below the open cradle-rods, which connect the steam and pump-cylinders. The valves are rubber disks, backed with iron, working vertically on fixed spindles. They are reached through the hand-holes, and are purposely made numerous in order to subdivide any trouble from the possible failure of any one of them. The duty trial of the Newark engine, reduced to the actual delivery of water in the reservoir, was by an average of the modes of calculation about 76,500,000 pounds lifted one foot high by 100 pounds of coal. See DUTY.

Du'plex-punch. 1. One having a counter-die mounted on an opposite jaw, as the ticket-punch.

2. One having a force derived from the rolling action of two levers on a common fulcrum, forming a toggle.

Fig. 1805.



Duplex-Punch.

Du'plex-tel'e-graph. A telegraph so arranged that messages can be simultaneously transmitted in opposite directions on the same line-wire.

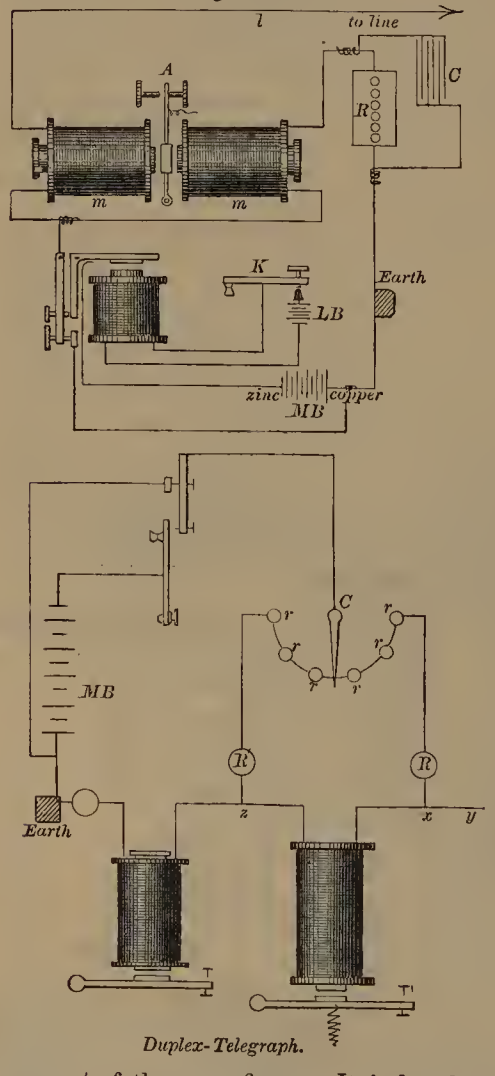
The first telegraph of this kind was devised by Dr. Gentl of Austria, in 1853, and modified by Frieschen and Siemens-Holske in 1854; but it is only within the past few years that any duplex systems have been put into successful operation, and, up to this time, only on American lines.

The system invented by Joseph B. Stearns, of

Boston, based upon Gentl's plan, is represented in Fig. 1806, in which the relay or receiving instrument is composed of two pairs of electro-magnets *m m* acting in opposite directions upon a common armature lever *A*. The key is the armature of an electro-magnet, which is in a local circuit controlled by a Morse key *K*. *L B* is the local battery. The main battery (*M B*) current is equally divided between the relay-magnets *m m*, one half passing through one set of magnets to the line *l*, and the other half passing through the other magnets, and a rheostat *R* — equal to the resistance of the main line — to earth *E*. The relay-magnets are thus equally excited and their influence upon the armature neutralized, so that the outgoing current gives no signal at the sending station. A current received, however, traverses only one set of the electro-magnets, destroying the equilibrium, and causing a signal. The key is so constructed that it closes one circuit to the earth before breaking another, thus always preserving the continuity of the circuit, a condition essential in systems of this kind. A condenser *C* is placed in a shunt circuit to the magnets in the short or home circuit, in order to neutralize the effect of the extra current on the line-magnets of the relay.

Another system of Mr. Stearns is shown in the

Fig. 1806.



Duplex-Telegraph.

lower part of the same figure. It is based on the arrangement of circuits known as the "Wheatstone bridge," the relay or receiving instrument being placed on the bridge. The current of the main battery is divided by the rheostats *r r* and *R R'* to points *x z*. If the resistances of circuits *C* to *z* and *C* to *x* are proportionately to each other as resistances of circuits *x y* or line, and *z* to earth, there will be no current in transmitting across the bridge *x z*, in which the relay or receiving instrument is placed. The larger portion of the incoming current, however, passes through and actuates the relay, as it offers the path of least resistance.

Moses G. Farmer, of Boston, invented a duplex system in 1858, in which he used a key which preserved the continuity of the circuit, and also reversed the battery at the sending station, this reversal making the signals at the distant station, the relay being prevented from responding by the current of a local equalizing battery closed simultaneously by this key.

Du'plex-type. (*Photography.*) A name given to a mode of taking two photographs of the same person in different positions by two operations, so that he shall appear in two characters — say, for instance, playing the piano, and — accompanying himself — on the violin. It is done by two exposures, with some skillful mode of hiding the division line. Shive's duplicating reflector is constructed for this purpose.

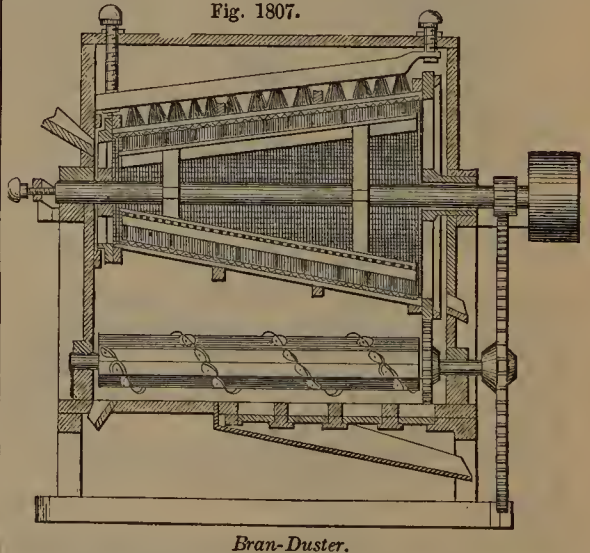
Du'rance. A stout woolen stuff formerly made in imitation of buff leather, and used for garments. *Durant.* Called also *Tammy.*

Du-rom'e-ter. An instrument invented by Behrens, designed for testing the relative hardness of steel rails. This "durometer," as it is styled, is virtually a small drilling-machine, working by hand or machine power, which registers the number of revolutions of the drill spindle and also the amount of feed, the latter being given by the application of a known weight to the back of the drill-spindle. The friction of the machine and the state of the cutting edges are supposed to be constant quantities, and as such are thrown out of the calculation. The hardness of a metal is considered to be inversely proportionate to the depth of feed obtained with a given number of revolutions.

Du-roy'. (*Fabric.*) A common quality of woolen serge.

Dust'er. 1. (*Paper.*) A machine for removing the dust from rags or other paper-making material

Fig. 1807.



Bran-Duster.

before sorting, cutting, and pulping. It consists of a revolving, wire-cloth cylinder inclosed in a box which receives the dust.

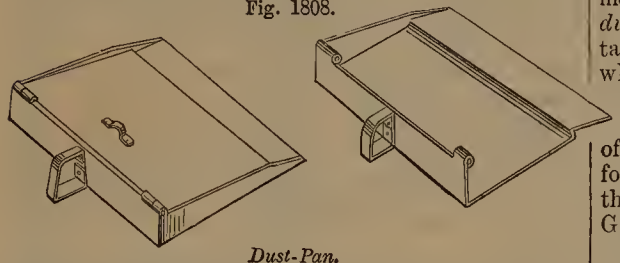
2. (*Milling.*) A machine for rubbing, brushing,

and blowing bran to remove particles of flour adhering thereto. The bran is fed in at a spout at the smaller end, and is driven and blown through the meshes of the conical screen.

Dust'ing-brush. One which has the thick end of the handle driven into the middle of the tuft of bristles. Or a feather brush.

Dust-pan. A domestic utensil for catching crumbs, lint, or dust, as they may be brushed from a table-cloth

Fig. 1808.



Dust-Pan.

or carpet. The example shown has a lid, handle, and an inclined plane with offset at the front edge.

Dust-shot. The smallest size of shot.

Dutch-case. (*Mining.*) A shaft-frame composed of four pieces of plank, used in shafts and galleries. A *mining-case.*

Dutch Clink'er. A yellow, hard brick made in Holland.

Dutch Foil. A copper alloy, rolled or hammered. See Dutch Gold, called also Dutch Leaf; Dutch Metal; Dutch Mineral.

Dutch Gold. The alloy used at the works of Hegermühl, near Potsdam, is composed of:—

Copper, 11; zinc, 2.

This is rolled into sheets, and is made into the Dutch leaf used in *bronzing.*

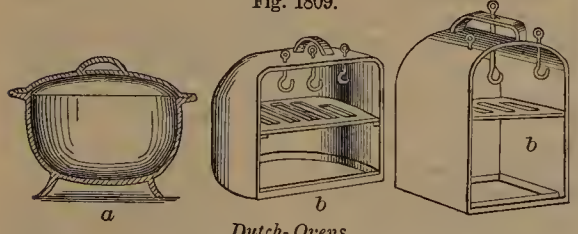
Dutch'ing. The process of removing the membraneous skin from the barrels of quills, and drying up the vascular membrane in the interior.

They are heated by plunging in hot sand, and then scraped to remove the skin. The heat shrivels the interior membrane and dissipates the oily matter of the quill, rendering it transparent.

Dutch'man. (*Carpentry.*) A playful name for a block or wedge of wood driven into a gap to hide the fault in a badly made joint.

Dutch-ov'en. (*Cooking.*) *a.* A *spider, skillet,* or *camp-oven* used by those who cook by hot coals on the hearth. A mode yet common in the West,

Fig. 1809.



Dutch-Ovens.

and unsurpassed in its results with skillful housewives. The pot stands in hot embers, and more of the same are piled on the dish-shaped lid.

b. A cooking-chamber suspended in front of a fire so as to cook by radiation. Also eminently satisfactory in its results, in just such degree as toasting exceeds baking; grilling or broiling than frying. It says, "Aha! I have *seen* the fire."

Dutch-scoop. A box shovel suspended by cords from a tripod and used for irrigation.

Dutch-tile. A variegated or painted glazed tile made in Holland and formerly used for lining their capacious fireplaces.

Dut'tees. Coarse, unbleached calicoes of India.

Du'ty. The useful effect of an engine in work performed.

This term was first explained in a definite and precise manner by Davies Gilbert, President of the Royal Society, in a paper read before that body in 1827. "The criterion of the efficiency of ordinary machines is force, multiplied by the space through which it acts; the effect which they produce, measured in the same way, has been denominated *duty,* a term first introduced by Mr. Watt in ascertaining the comparative merit of steam-engines, when he assumed one pound raised one foot high, for what has been called in other countries the dynamic unit; and by this criterion one bushel of coal has been found to perform a duty of thirty, forty, and even fifty millions." This has been more than doubled since the writing of the paper of Mr. Gilbert.

The duty is not an expression of the work done, as this would include the power to overcome friction and other resistances, but is the actual useful effect, expressed in pounds weight, of water actually raised.

The duty of the Newark water-work duplex-pumping engine, as obtained by multiplying together the area of the plunger in square inches (373.85), and the pressure in pounds per square inch (75.68), to obtain the load in pounds, and this by the travel of the piston in feet per hour (10,908.4), and dividing this product by the number of hundreds of pounds of coal consumed per hour (4), was 77,157,840 foot-pounds. As obtained by multiplying the displacement per stroke in cubic feet (10.4042), into the number of strokes per hour (2722), the weight in pounds of a cubic foot of water (62.5), and the height in feet to which the water was raised for delivery (174.82); and dividing this product by the number of hundreds of pounds of coal consumed per hour (4), the duty was 77,358,478. As reduced to the actual delivery of water in the reservoir, it was 76,386,262 and 76,584,894 by the two methods respectively.

The following is the duty officially given for the engines cited:—

Brooklyn, No. 1, double-acting beam .	60,140,700
Belleville (Jersey City), Cornish .	62,823,300
Hartford (3 experiments), crank	58,779,300 to 64,669,400
Brooklyn, No. 3, double-acting beam .	72,000,000
Cambridge (2 experiments), Worthington double-cylinder, not duplex	66,941,100 to 67,574,600
Spring Garden (Philadelphia), Cornish	58,905,300

The *duty* or useful effect of the Cornish pumping-engine has been more closely observed and recorded than that of any other engine. The *duty* is reported monthly, and is reduced to tabulated form, from which the yearly report is made out.

The duty of these engines has been gradually improved. It is estimated by the number of pounds raised one foot high by a bushel of Welsh coals, 94 pounds.

	Pounds, 1 foot high.
In 1769, the Newcomen engine . .	5,500,000
In 1772, the Newcomen engine, improved by Smeaton . . .	9,500,000
In 1778 to 1815, the Watt engine .	20,000,000
In 1820, the improved Cornish engine, average duty	28,000,000
In 1826, the improved Cornish engine, average duty	30,000,000

	Pounds, 1 foot high.
In 1827, the improved Cornish engine, average duty	32,000,000
In 1828, the improved Cornish engine, average duty	37,000,000
In 1829, the improved Cornish engine, average duty	41,000,000
In 1830, the improved Cornish engine, average duty	43,350,000
In 1839, the improved Cornish engine, average duty	54,000,000
In 1850, the improved Cornish engine, average duty	60,000,000
Consolidated mines, highest duty 1827	67,000,000
Fowey Consols (Cornwall), highest duty 1834	97,000,000
United mines, highest duty 1842 .	108,000,000

D-valve. A species of slide-valve, employed chiefly in the steam-engine, and adapted to bring each steam-port alternately in communication with the steam and exhaust respectively.

Dwang. 1. A large iron bar-wrench used to tighten nuts on bolts.

2. A crow-bar used by masons.

Dwarf-raft'er. (*Carpentry.*) Little jack. A short rafter in the hip of a roof.

Dwarf-wall. A low wall serving to surround an inclosure; such a wall as that on which iron-railing is commonly set.

Dye'ing. Dyeing is a subject not involving much machinery, and is therefore hardly within our limits.

Dyes are organic and inorganic.

The former are vegetable, except cochineal, sepia, and the purple of the murex.

Most of the vegetable colors do not exist naturally in plants, but are obtained by subjecting vegetable substances to special chemical treatment; as in the case of *garancine*, obtained from madder.

The art of dyeing consists in impregnating fiber, in the state of cloth or otherwise, with coloring substances.

Fibrous materials differ in their relative disposition to *take* color. Their disposition to absorb and retain color is in the following order, beginning with the one which has the greatest attraction for color: —

Wool.	Flax.
Silk.	Hemp.
Cotton.	

Woolen goods dyed before weaving are called *wool-dyed;* if after weaving, *piece-dyed.*

Dye-colors are *substantive* or *adjective.*

The former act directly, imparting their tints by simple immersion in their infusions or decoctions; the latter intermediately, and are the more numerous, requiring *fixing* or *striking.*

The intermediate substances are called *mordants.*

The mordant is first applied, and causes the dye which follows to adhere to the fiber, often singularly affecting its tint. Thus: cotton dipped in a solution of copperas (*mordant*) and then in a solution of logwood (*dye*) becomes black. If a solution of tin (*mordant*) be substituted for the salt of iron, the tint imparted by the logwood will be violet. Mordants were used in China and India from very distant periods, and are described by Pliny. See CALICO-PRINTING.

Moses (1490 B. C.) speaks of stuff dyed "blue, purple, and scarlet"; "rams'-skins dyed red."

Joseph (1729 B. C.) had a coat of many colors; probably a product of Damascus.

Dyeing is attributed to the Phœnicians. Solomon (1000 B. C.) sent to Hiram of Tyre for a man "cunning to work in . . . purple and crimson and blue." Ezekiel speaks, in his burden of Tyre, of the "blue and purple from the isles of Elisha," which may mean the Peloponnesus and adjacent islands.

The most celebrated dye of antiquity was the Tyrian purple, derived from a species of murex. Pliny cites two, the *buccinum* and *purpura.* A single drop of fluid was obtained from a sac in the throat of each animal. A quantity was heated with sea-salt, ripened by exposure for three days, diluted with five times its bulk of water, kept warm for six days, being occasionally skimmed; then clarified and applied as a dye to white wool previously prepared by the action of lime-water or fucus. The wool was first plunged into the *purpura* and then into the *buccinum.* Sometimes a preliminary tint was given with coccus (kermes). The dye and dyed goods are celebrated in the Hebrew and other ancient scriptures.

This color seems, from its extreme beauty, permanence, and costliness, to have become regal, and the royal taste is for the same down to our day. The color of the velvet in the crown of the Queen of England is a shade of purple; the velvet coronation robes of George IV. were of that color. Pliny (A. D. 70) says that the robes of triumph in the time of Homer (900 B. C.) were colored. Purple habits were given to Gideon by the Israelites from the spoils of the kings of Midian. Achan secreted a Babylonish garment, and suffered for it. Plutarch says that when Alexander took Susa, the Greeks took from the royal treasury purple stuffs to the value of 5,000 talents (1 talent $\$860 \times 5{,}000 = \$4{,}300{,}000$), which still retained their beauty, though they had lain there 190 years.

Prussian blue was discovered by Diesbach, at Berlin, 1710; aniline, in 1826, by Unverdorben. In 1856, Perkin, experimenting with aniline, treated it with bichromate of potassa, and obtained *mauve.* Arsenic tried as a substitute for bichromate of potassa produced *magenta;* blue, green, violet, and other colors were subsequently produced.

(*Hat-making.*) Hats (black) are dyed in a solution of sulphate of iron, verdigris, and logwood, at a temperature of 180° F. They are alternately dipped and aired, the process being repeated perhaps a dozen times. The hats are all on thin blocks, and a *suit* of five dozen fills a crate, which is swung from a crane, and thus raised and lowered as required.

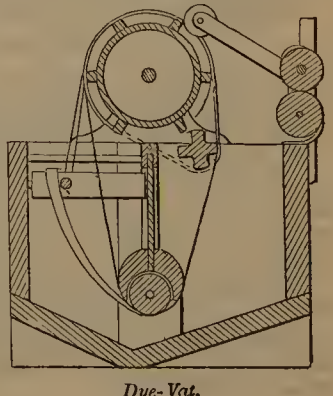
Dye-ket'tle. (*Hat-making.*) The vat of dyeing liquid in which hats are dipped to color them. It contains a solution of sulphate of iron, verdigris, and logwood, is maintained at 180° F., and the crate of hats on their blocks is repeatedly dipped and aired to confer the requisite depth and gloss of color.

Dy'ers'-bath. The dyeing material in the vat in which the fabric is immersed.

Dy'ers' Spir'it. Nitro-muriate of tin. Employed as a mordant.

Dye-vat. A beck or tub in which goods in piece or otherwise are saturated with a dye or a mordant in solution. In Fig. 1810, the piece of cloth, its ends being sewed together and rounded in

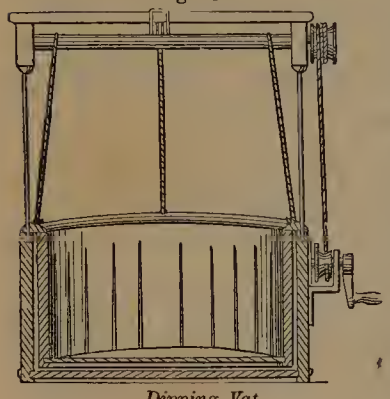
Fig. 1810.



Dye-Vat.

form, is coiled around the rollers in a devious course. so that the whole piece has continuous movement, in which it is alternately carried beneath and raised from the liquid dye. When the cloth has been sufficiently dipped the ends are unsewn, and the forward end is passed between the wringing rollers in a flat form.

Fig. 1811.

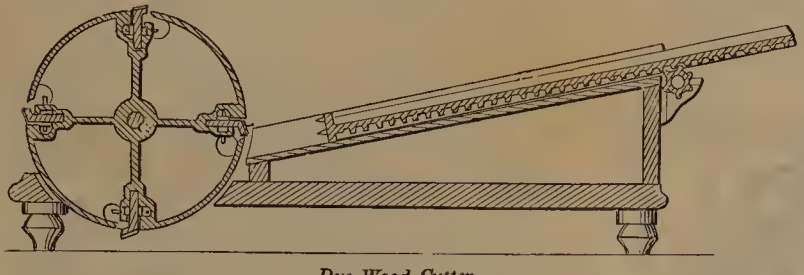


Dipping-Vat.

In another form, the goods are contained in a basket, which is dipped into the vat and raised by crank and rope.

Dye-wood Cut'ter. A machine for shaving wood into small chips; usually has a revolver-cutter, and resembles a rotary planer, except that it reduces the whole body of the log to chip. The rotating drum has adjustable serrated cutters. The wood is fed on an inclined slide, and propelled by a toothed follower,

Fig. 1812.



Dye-Wood Cutter.

actuated by a spur-wheel and rack. See also BARK-PLANING MACHINE; ROSSING-MACHINE.

Dyke. 1. (*Mining.*) A bank of basalt or whin by which the strata or lodes are frequently divided.

2. A sea-wall. See DIKE.

Dy-nac'ti-nom'e-ter. An instrument described by M. Claudet ("Philosophical Magazine," June, 1851), for measuring the intensity of the photogenic rays of light, and computing the power of object-glasses. See ACTINOMETER.

Dy-nam'e-ter. An instrument for measuring the magnifying power of a telescope.

The magnifying power is the ratio of the solar focal distance of the object-glass to the focal distance of the eye-piece considered as a single lens; and this ratio being the same as the ratio of the diameter of the aperture of the telescope to the diameter of its image or disk formed at the solar focus, and seen through the eye-piece, the object of the instrument is to measure the exact diameter of this image, which can be either projected on mother-of-pearl or measured by optical means.

Ramsden proposed for this purpose the double-image micrometer, an instrument formed by dividing the eye-lens of a positive eye-piece into two equal parts, and mounting them so that the divided edges are made, by means of a fine screw apparatus, to slide along each other. Each semi-lens thus gives a separate image; and the distance of the two centers, measured by the revolutions of the screw, when the borders of the two images are brought exactly into contact, gives the distance of the centers of the images, or the diameter of one of them.

Dyn'a-mite. An explosive compound invented by Nobel. "It is a mixture of 75 per cent of nitro-glycerine with 25 per cent of infusorial silica. The silica renders the powder less liable to explode from concussion. This is the dynamite proper, but dynamite is also used as a generic name for other mixtures of nitro-glycerine,—as colonia powder, which is gunpowder with a mixture of 40 per cent of nitro-glycerine; dualine, which contains 30 to 40 per cent of nitro-glycerine mixed with sawdust saturated with nitrate of potassia; lithofracteur, which contains 35 per cent of nitro-glycerine mixed with silica, and a gunpowder made with nitrate of baryta and coal."—*Journal of Applied Chemistry.*

Dyn'a-mom'e-ter. A power measurer.

Graham's dynamometer, improved by Dr. Desaguliers, is an application of the ordinary steelyard, in which the power to be measured is exerted upon the short arm and ascertained by a weight on the longer, graduated arm.

Leroy's dynamometer is a spiral spring in a tube. Power is applied to condense the spring, and the pressure indicated by a graduated bar. This is equivalent to the ordinary spring-balance, and is a very ready form of dynamometer for moderate forces.

Regnier's dynamometer (1, Fig. 1813) consists of an elliptic spring whose collapse in the direction of its minor axis is made to move an index-finger on graduated arcs.

The power may be applied in two ways: when it is applied to draw the ends *s s* apart, the index-finger registers myriagrammes on the outer scale; but when the two leaves of the spring are grasped by the hands and thus pressed by a power applied at right angles to the former, and in the most effective direction, a shorter pin on the same pointer registers kilogrammes on the inner arc of graduations.

The graduated plate with its pointers belongs to one leaf of the spring,—the upper leaf in the illustration,—while the other leaf connects by a small copper lever with an arm which pushes the index-finger as the elliptical spring is collapsed by force applied to it. The index-finger moves freely and retains the attained position, being unaffected by the relaxation of the force.

For moderate forces the power is applied to condense the spring by directly pressing the leaves together in the line of the minor axis. For superior forces the spring is collapsed by direct draft outward, upon the loops *s s* at the ends of the spring.

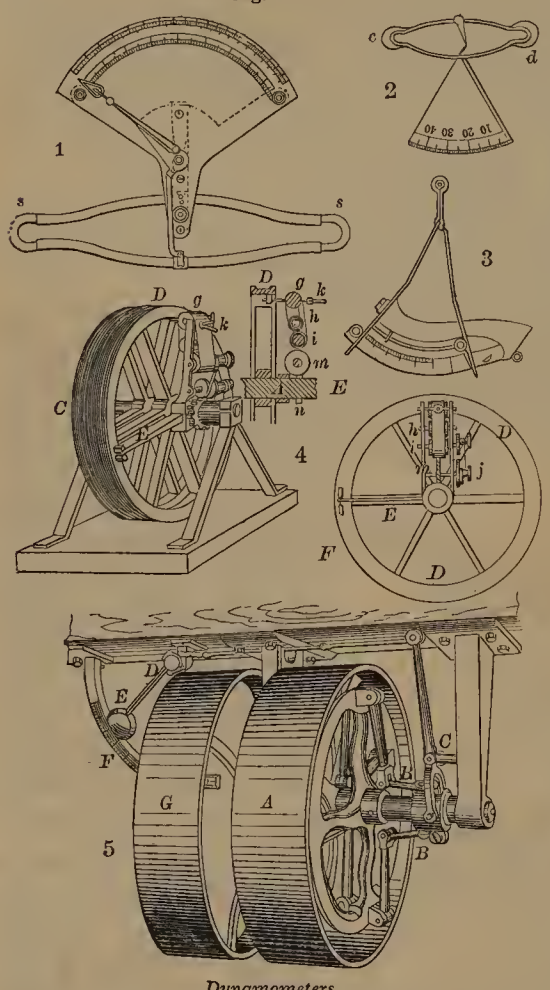
Braby's dynamometer (2, Fig. 1813) has an elliptic spring like Regnier's, but a somewhat different recording connection. Like Regnier's heavier draft, it is attached by the ends *c d*, between the power and the load, and the application of force collapses the leaves of the spring, oscillating the index-finger on its axis, and recording upon the graduated arc the amount of power exerted.

The Sector dynamometer (3, Fig. 1813) is made of a bar of steel, bent in the middle, and having a certain flexibility. To each limb is attached an arc which passes through a slot in the other limb. Loops at the ends of the arcs permit the device to be placed between the power and the load, so that the limbs are approached when power is applied. One arc is graduated so as to indicate the power exerted in bringing the limbs nearer together. The

graduations made on the arc are in accordance with the result of the suspension of weights experimentally.

The above forms are specifically adapted for pulling forces, such as testing strengths of cords, power of animals, force required to draw plows, carriages, etc. When the problem is to ascertain the force transmitted through a revolving shaft, the case is somewhat more complicated. "A mechanical con-

Fig. 1813.



Dynamometers

trivance for measuring the force exerted by a prime mover, or the amount of force consumed in driving a machine or all the machines of an industrial establishment. It involves generally the expedient of interposing between the motor and the machine, as a medium through which the power is to be transmitted, some combination of springs, or some mechanism of which springs are the essential parts, provided with a scale on which are marked the degrees of static force corresponding to different states of tension, and sometimes also with automatic machinery for making periodical record of the marking of the index on the scale." — BARNARD.

Prony's friction-brake is a test which involves the loss of power, as it consists in opposing a frictional impediment to the motion. The measure is relative as compared with other machines similarly tested, and is determined by the power evinced to resist given frictional opposition to the continuance of the motion.

Thompson's friction-brake dynamometer has been contrived for estimating the amount of power transmitted through a shaft by means of clamping-blocks, a lever, and suspended weights. The requirement of a perfect dynamometer is that it shall not be itself a charge upon the power; that is, that by its interposition the expenditure of driving force required shall not be sensibly increased. This property belongs to all that class in which the power of the motor acts directly with all its force to produce flexure in springs, while the springs by their effort of recoil transmit it undiminished to the machine.

Taurine's dynamometer forms a section interposed between two lengths of a shaft in line. Two arms are attached to the part of the shaft on either side of this joint, in a radial direction; those on the same side being diametrically opposite to each other, while those of each pair are ninety degrees from those of the other. Stout springs in the form of circular quadrants connect the extremities of these arms on two opposed quarters of the circle, and the force of the motor is transmitted through these springs by a pushing effort. The effect is to bend the arches outward, and the degree of this bending is indicated by a spring which connects their middle points. The flexure of this spring is diminished, and in straightening it moves an index in the direction of the axis of rotation.

Bourdon's dynamometer depends upon the transmission of the power by means of slightly spiral gearing, the tendency of which is to give the arbor of the gear a longitudinal motion in its bearings. This motion is opposed by a spring, and the degree of compression of the spring is the measure of the power transmitted.

Horn's dynamometer acts upon the principle of the torsion of the connecting-shaft.

The dynamometer (4, Fig, 1813) used by the jury of Class V. (*machines for direct use*) in the International Exhibition, London, 1851, was the invention of Colonel Morin of France.

To the shaft *A* is secured a pulley *C*, and on the same shaft is a loose pulley *D* which has a spring-bar *E* extending between cheeks on pulley *C*, which is the only connection between them. When a force is applied to *D* and a resistance to *C*, the spring *E* is flexed, and the degree of flexure is the measure of resistance. To measure the degree of bending of the spring a frame is attached to the boss of the spring *E* supporting a series of rollers *g h i* a fusee *j* and pencil-holder *k*. On the edge of the pulley *D* is another pencil-holder. When the dynamometer is to be used, a long ribbon of paper is wound on the roller *h*, and its outer end being carried over the roller *g* is made fast to *i*, which is driven by a string from the fusee *j*, which bears on its axis a wheel *m* gearing into one on the shaft *A*. Until resistance is applied to the wheel *C* the two pencils make a single line, but when the spring is flexed the lines of the pencils diverge, one pencil continuing to draw a straight line and the other tracing a line at a distance from the first, varying with the degree of flexure.

Emerson's lever-dynamometer (5, Fig. 1813) is also designed for measuring power in transmission. The pulley *A* is loose on the shaft, and receives the power. Its connection with the shaft is made by means of a wheel keyed to the shaft and connected to the pulley by certain levers which have connection *B C D* with a pendulous weight *E* which registers on a scale *F* the amount of power exerted upon *A* to produce the motion of the pulley *G*, which is fixed to the shaft and delivers the power.

For medical uses a dynamometer is made compressible in the hand.

Dyn'a-mo-met'ri-cal-brake. A form of DYNAMOMETER (which see).

E.

Ear. A small projection on an object, usually for support or attachment; as:—

1. The *ear* of a bucket or cooking-pot to which the bail is attached. The *car* or *lug* of a sugar or salt boiling kettle by which it is supported on the walls of the furnace. The ear of a shell is imbedded in the metal, and serves for inserting the hooks by which the projectile is lifted.

2. (*Music.*) In the metallic mouth-pipe of an organ; one of the pair of soft metal plates at each end of the slit or mouth of the pipe, which may be bent more or less over the opening, to qualify the tone.

3. The *canon* of a bell, the part by which it is suspended.

4. (*Printing.*) A projection on the edge of the frisket; or one on the edge of the composing-rule.

5. The loop or ring on the ram of a pile-driver by which it is lifted.

6. One of the two projecting parts on the portions of an eccentric strap by which they are bolted together.

Ear, Ar'ti-fi'cial. An auricle having the shape of the natural ear, and worn as an ear-trumpet, to collect the waves of sound and conduct them by a tube to the *meatus auditorius.* Usually made of gutta-percha colored to resemble nature, and attached by clasps to the natural ear. See AURICLE.

Ear-brush. A toilet instrument for cleaning the ear. A bulb of sponge on a handle. An *auriluve.*

Ear-cor'net. A small auricle which is contained within the hollow of the outer ear and has a short tube to keep open the *meatus auditorius* in cases of contraction or the presence of polypi. An *ear-trumpet.*

E-lec'tro-mag-net'ic Bat'ter-y. One in which the current is generated in the voltaic battery, as distinguished from the *electric,* the *magneto-electric,* or the *thermal* battery.

Ear'ing. (*Nautical.*) The rope which lashes the upper corner of a sail to its yard.

The *reef-earings* are used to lash the ends of the reef-band to the yard.

Ear of Di'o-nys'i-us. An acoustic instrument named after the sound-conducting orifice in the roof of the dungeons where the old Sicilian tyrant kept his prisoners.

It has a large mouth-piece to collect the sound, which a flexible tube conducts to the ear of the person. It is especially adapted for enabling the very deaf to hear general conversation, lectures, sermons, etc. See ACOUSTIC INSTRUMENTS.

Ear-pick. (*Surgical.*) A small scoop to extract hardened cerumen from the *meatus auditorius,* or foreign matters from the external ear.

Ear-spec'u-lum. (*Surgical.*) An instrument for distending the exterior canal of the ear, in removing indurated wax, or other explorations and operations. An *otoscope.*

Ear-syr'inge. An instrument for injecting the ear with a liquid or medicated vapor. An ordinary syringe may answer the usual purposes of cleanliness, softening indurated wax, etc., but the instrument shown has a farther capacity. *a* is an india-rubber air-bag, *b* a flexible tube, *c* a bulb of hard-rubber, made in two pieces, which screw together and contain a sponge to hold chloroform or other liquid; *d* is the perforated bulb. It is particularly used in treating diseases of the middle ear. The sponge being previously moistened, the nozzle of the bulb is placed in one nostril, the other is closed by the finger of the surgeon, the mouth is also closed, and the patient, having previously taken a mouthful of water, is told to swallow, and, just as he is doing this, the surgeon compresses the air-bag, and sends the iodized air into the faucial orifice of the eustachian tube, and, if the drum be perforated, into the cavity of the tympanum.

Fig. 1814.

Rcosa Ear-Syringe.

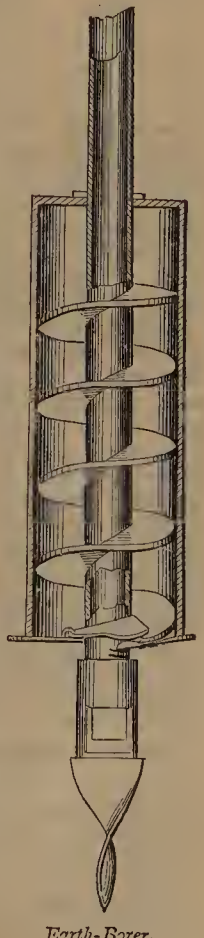
Earth. (*Telegraph.*) The ground in its relation to the circuit as the means of conducting the return current. The conductor is led to a buried ground-plate or to a gas or water main, which forms an admirable ground conductor.

Earth-bat'ter-y. A large plate of zinc and a plate of copper, or a quantity of coke, buried at a certain distance asunder in damp earth. The moisture of the earth acts as the exciting fluid on this voltaic couple, and a feeble but constant current is produced.

Earth-board. The mold-board of a plow.

Earth-bor'er. A form of auger for boring holes in the ground, where the strata are sufficiently soft and loose. The shaft has a screw-point and a cutting-face. The twisted shank revolves inside a cylindrical case, which retains the earth till the tool is withdrawn. The valve opens to admit the earth, and closes as the tool is lifted. See AUGER.

Fig 1815.



Earth-Borer.

Earth-car. A car for transporting gravel and stone in railway operations. See DUMPING-CAR.

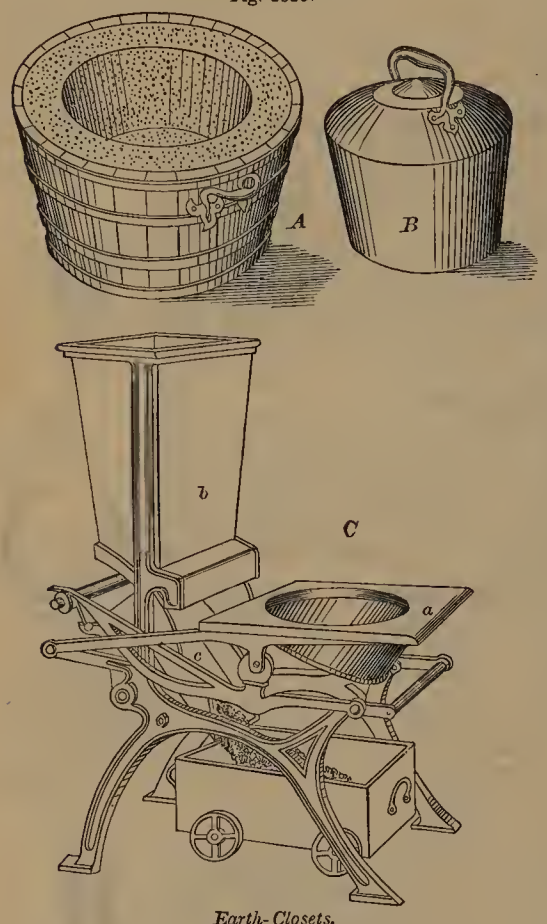
Earth-clos'et. A commode or night-stool in which a body of earth receives the feces, or is dropped upon them to absorb the effluvia; the resultant is to be utilized as a fertilizer.

A is a pan provided with an absorbent; when full, the lining and the contents are removed and buried, and another lining of earth placed in the pan by packing around the mold *B.*

C has a seat *a,* which descends with the person and brings a charge of earth in readiness to fall upon the feces. As the person rises, the quantity of earth released by the former operation is dropped upon the feces in the pan below. *b* is the earth reservoir, and *c* the dumping-spout.

Earth'en-pipe. The Romans used earthen pipes where economy was an object. They preferred lead. The earthen pipes had a thickness of at least two inches, and the ends were respectively contracted and enlarged to fit into and to receive the

Fig. 1816.



Earth-Closets.

adjacent pipes. The joints of the pipes were luted with quicklime and oil. The thickness was increased at the bottom of a bend, as in crossing a valley or hollow, or the pipe at this part was "secured by ligatures or a weight of ballast" (VITRUVIUS). Earthen pipes are found in the walls of the baths and the Coliseum, of various diameters, none less than 2 inches diameter. The elaborate arrangement of pipes in the amphitheater of Vespasian has probably never been excelled. Fifty-six drains constructed within the thickness of the walls which supported the staircases of the ground-floor served to carry off the rain-water which fell in the building, and also the contents of the urinals in the third and fourth stories. The drains were cylindrical pipes of 12 inches diameter, hollowed out of freestone blocks 20 inches in hight. The drains were led down from the upper stories through pipes in the masonry of the stairs, and united with hundreds of other drains at the larger conduits, which conducted the water to the Cloaca Maxima.

The arrangement of the aqueduct and distributing pipes which conducted the water from the fountain of Nismes was as elaborate as the emunctories described. See "Cresy," ed. 1865, pp. 108–118.

Earth'en-ware. A general expression which covers all ceramic work, such as stone-ware, delft, porcelain, etc. See POTTERY. The term, as far as it may have a less general meaning, includes merely the commoner classes of clay-ware, otherwise known as *crockery*.

The clay, having been properly tempered, is formed on the wheel and dried under cover until it has acquired considerable solidity. The glaze, of the consistence of cream, is then put on as evenly as possible by means of a brush. Small articles are glazed by pouring in the glaze and then pouring it out again, sufficient adhering for the purpose.

The glaze consists of galena ground to powder and mixed with "slip"; that is, a thin solution of clay. This is a clear glaze, and is made black and opaque by the addition of manganese: galena, 9; manganese, 1 part. The glaze having dried, the ware is piled in the kiln.

A low heat, applied for twenty-four hours, drives off the moisture; an increased heat for another twenty-four hours, as high as can be borne without fusion, bakes the clay, drives off the sulphur from the galena, and causes the lead to form a glass with the clay to which it adheres. With increase of heat this glass spreads over the surface of the ware. After the furnace is cooled, the ware is removed. The glaze, consisting of oxide of lead, is soluble in acids, such as vinegar and those of fruit, and is destroyed, rendering injurious the food with which it combines. A more refractory clay admits the use of a less fusible glaze of a harmless character.

Earthen-ware is found among almost all nations and tribes, though not all have the art of glazing, nor have all the art of baking. *Drying* is not *baking*, and it requires a good heat to make a good ringing article. The Egyptians and Etruscans had pottery at a date before the historic period. We know more of the former than of the latter at early periods. The resemblance of the Greek and Etrurian ceramic works is remarkable. Glazing came from China. Wedgwood's patents about 1762. See specific list under POTTERY AND CLAY.

Earth-plate. (*Telegraph.*) A plate buried in the earth, or a system of gas or water pipes utilized for the purpose, connected with the terminal or return wire at a station, so as to avail the earth itself as a part of the circuit, instead of using two wires, as was the practice previous to 1837.

Earth'quake-a-larm'. An alarm founded on the discovery or supposition that a few seconds previous to an earthquake the magnet temporarily loses its power. To an armature is attached a weight, so that upon the magnet becoming paralyzed the weight drops, and, striking a bell, gives the alarm.

Earth-ta'ble. The lowest visible course of stone or bricks in a wall or building.

Earth'work. An engineering term applied to cuttings and embankments.

Ear-trum'pet. An instrument for the collection and conduction of sounds. By increasing the size of the auricle, a larger volume of sound is gathered than by the natural ear.

The ear-trumpet for the assistance of the partially deaf is believed to have been invented by Baptista Porta about 1600. Kircher describes the funnel and tube for conveying sound, the device which is now so common for conveying intelligence between apartments and shops, in dwellings, warehouses, and factories.

Dr. Arnott of England, who became partially deaf from a cold contracted in traveling, first devised the pair of shells or artificial ears which extend the surface displayed to gather the tremulous air.

There are two qualities required in a speaking-tube: that it shall concentrate a large amount of sound in a small space; and, secondly, that it shall not stifle the sounds within the tube itself. Gutta-percha seems to answer the latter conditions better than any other material.

The ear-trumpets are of several descriptions:—

1. The *long ear-trumpet a*, with a wide opening at the sound-reception end, and a small opening at

the delivery end. This is made portable and compact by bending. *b* has a rotatable section; *c* is a shorter trumpet; *d d* cane trumpets; *e* a short one.

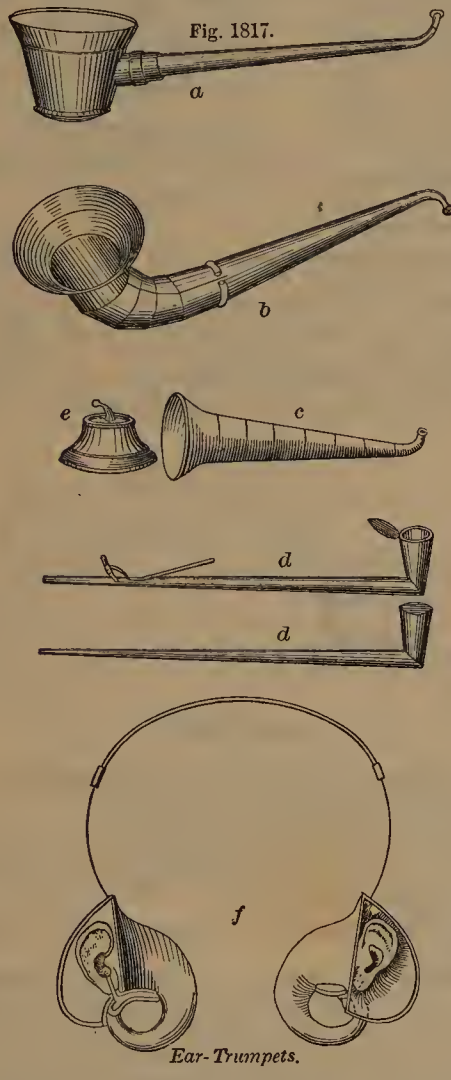
2. The ear-cornet *f* is a small and neat affair, adapted to be worn on the head.

3. The *paraboloid trumpet*, in which the sound is echoed from a large concave receiver before it enters the tube.

4. The auditorium trumpet, which is adapted to collect the sound of a speaker's voice and convey it to one or more parts of the room where the partially deaf persons may be sitting.

The uses of the acoustic tubes are various, form-

Fig. 1817.



Ear-Trumpets.

ing means of communication between a captain and his engineer or steersman; a conductor and driver on a street-car; a conductor and engineer on a train; a messenger at the door and a doctor in his apartment; a housekeeper with the kitchen; an office with a factory; an editor with the compositor's room; a hospital office and the wards, etc.

In the auricle *f* the tube of the ear-trumpet near where it enters the ear is intersected by a passage communicating with an artificial ear which is intended to lead such vibrations as fall on it to unite with the vibrations passing round through the tube.

A *sonifer* is a bell-shaped instrument of metal placed on a table with the mouth turned in the direction whence the sound proceeds; the sound collected in the bottom of the instrument is conducted by a flexible tube to the ear of the person.

(*Microcoustic.*) An instrument to assist the hearing.

Eas'el. A wooden frame for supporting a picture during its execution.

Fig. 1818.

Easel.

Eave. The lower edge of a roof overhanging the wall.

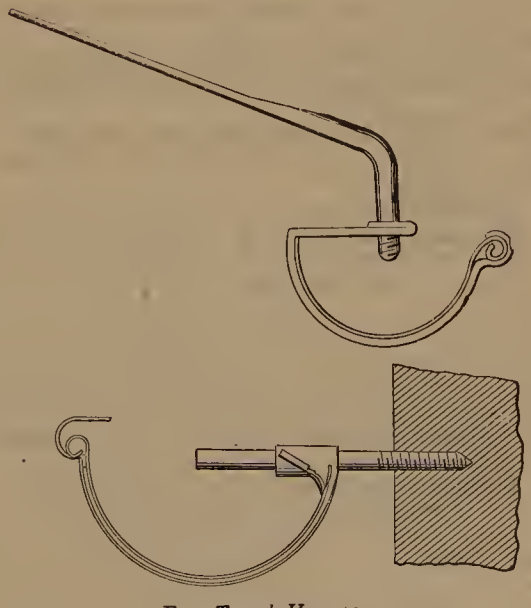
Eave-board. A feather-edge board, nailed above and across the lower ends of the rafters, to tilt up the lower edge of the lowest course of slates so that the next course may lie flatly upon them.

Eave-lead. (*Building.*) A leaden gutter inside a parapet.

Eave-mold'ings. (*Architecture.*) Those immediately below the eaves, as a cornice.

Eave-trough. A trough, usually of tinned iron, suspended beneath an eave to catch the drip. It is

Fig. 1819.



Eave-Trough Hangers.

held by a strap or hanger, which may have means for the vertical adjustment of the trough, so as to give it the required fall in the length of the eave.

Eb'on-ite. Mr. Goodyear's name for what is generally known as hard rubber. It is a vulcanite with a larger proportion of sulphur and certain added ingredients. The proportion of sulphur is from thirty

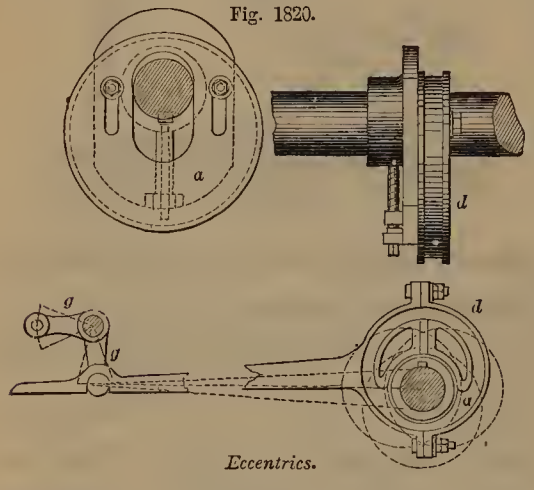
to sixty per cent, and to this may be added certain amounts of shellac, gutta-percha, chalk, pipe-clay, sulphates of zinc, antimony, or copper. It is used of many colors, as may be gathered from the above list of ingredients, and of hardness and consequent facility for taking polish. The compound, mauger its name, may resemble horn, ivory, bone, wood, etc.

E-bul'li-o-scope. An instrument for determining the strength of a liquid by ascertaining its boiling-point.

Ec'cal-e-o'bi-on. A chamber for hatching eggs by artificial heat. See INCUBATOR.

Ec-cen'tric. A disk or wheel *a* fixed upon a shaft at some distance from its geometric center. Around it is placed a ring *d*, within which it is at liberty to turn; the ring, however, does not turn,

Fig. 1820.



Eccentrics.

but rotates around the axis of *a*, so as at its quarterly points to occupy the places indicated by the dotted circles, the effect of which is to rock the bell-crank lever *g g*.

The upper portion of the figure shows a shiftable eccentric for varying the throw.

The *fore eccentric* and *back eccentric* impart forward and backward motions respectively to the valve-gear and the engine.

The eccentric is used in many other machines besides steam-engines, to convert a rotary to a reciprocating motion.

Ec-cen'tric-catch. See ECCENTRIC-HOOK.

Ec-cen'tric-chuck. A chuck attached to the mandrel of a lathe, and having a sliding piece which carries the *center*. This piece is adjustable in a plane at right angles to the axis of motion by means of a set screw, and carries the center to one side of the axis of motion. By its means circular lines of varying size and eccentricity may be produced. No oval or ellipse is produced thereby, but circles on the face of the work with their centers at such distance from the axis of the mandrel as may be desired.

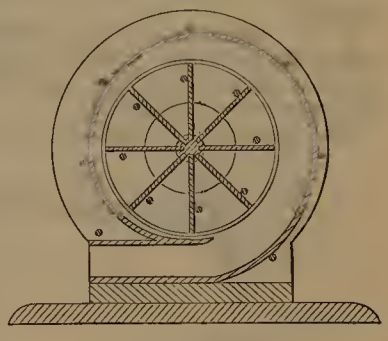
Ec-cen'tric-cut'ter. A cutting-tool placed upon the slide-rest, and having a rotation by means of a wheel and shaft, the cutter being attached to the end of the latter. The rotation is obtained by an *overhead motion*, and the eccentricity by fixing the cutter at different distances from the center by means of the groove and screw. The action of the eccentric-cutter differs from that of the eccentric-chuck in this: in the latter the work is rotated and the tool is stationary; in the former the work is stationary and the tool revolves.

When the motions are used in conjunction, the patterns are capable of almost unlimited variation.

Ec-cen'tric-en-grav'ing. An arrangement of diamond tracers, operated by elaborate machinery, acting upon a varnished roller designed for calico-printing. The effect is analogous to that produced by the rose-engine lathe.

Ec-cen'tric-fan. A fan-wheel with radial arms and vanes, and having an axis which is eccentric with the case in which it revolves. The case has a scroll form, and the effect is to make the discharge of air more perfect and avoid carrying a body of air around between the vanes.

Fig 1821.

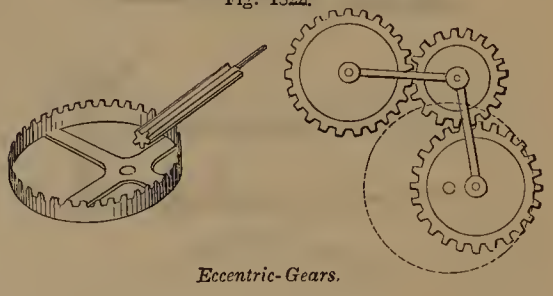


Eccentric-Fan.

Ec-cen'tric-gab. See ECCENTRIC-HOOK.

Ec-cen'tric-gear'ing. Cog-wheels set on eccentric axes give a variable circular motion, as in the case of the eccentric *contrate wheel* and pinion, and the eccentric spur-wheel and intermediate shifting pinion. Links connect the axis of the pinion with those of the *driver* and *driven* wheels, and preserve the pinion at proper meshing distance,

Fig. 1322.



Eccentric-Gears.

so as to engage with the *motor* and communicate the motion to the next wheel in series.

Ec-cen'tric-hook. (*Steam-engine.*) One used to connect the eccentric-rod with the wrist on the lever of the rock-shaft which actuates the valve; otherwise called a *gab*.

Ec-cen'tric-hoop. The strap on the eccentric of an engine.

Ec-cen'tric-pump. A hollow cylinder in which is a revolving hub and axis eccentrically arranged. On the hub are flaps which act as pistons in the space between the hub and the case to expel the water, which enters at one opening and departs by another. The same construction is seen in rotary steam-engines, only that in one case the shaft revolves to force water, and in the other the steam passes through to drive the shaft.

Ec-cen'tric-rod. The rod connecting the eccentric strap to the lever which moves the slide-valve.

Ec-cen'tric-strap. (*Machinery.*) The ring inclosing an eccentric sheave and connecting by a rod to the object to be reciprocated; as, the slide-valve of a steam-engine. See ECCENTRIC.

Ec-cen'tric-wheel. A cam consisting of a circular disk attached eccentrically to a shaft. It is used for communicating a reciprocating motion to the valve of a steam-engine. Its axis of revolution is out of the center of its figure, and the rectilinear motion imparted is called the *throw*.

The ring around the eccentric is the *eccentric-strap*.

The rod connecting the strap to the part to be actuated is the *eccentric-rod.*

The hook at the end of the rod, by which it is connected to the rock-shaft of the valve motion, is the *eccentric hook* or *gab.*

The whole apparatus is the *eccentric-gear.* See ECCENTRIC.

Ec-cop'e-us. (*Surgical.*) A surgeon's knife.

A *raspatory ;* an ancient instrument for trepanning.

E-chi'nus. A member of the Doric capital ; so called from its resemblance to the echinus, or large vase, in which drinking-cups were washed.

E-chom'e-ter. (*Music.*) A scale or rule marked with lines which serve to indicate the duration of sounds, and to ascertain their intervals and ratios.

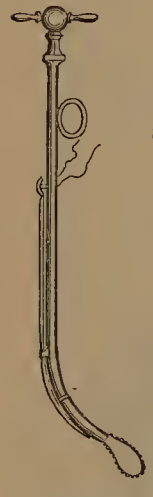
E-clipse'-speed'er. (*Cotton*, etc.) A form of spinning-machine.

E'coute. (*Fortification.*) A gallery built in front of the glacis of a fortification, as a lodgment for troops to intercept the miners of an attacking force.

Ec-pho'ra. The projection of any member or molding before the face of the member or molding next below it.

E-cra'seur. A steel chain tightened by a screw, and used for removing piles, polypi, malignant growths, etc. Used also in obstetrical practice.

Fig 1823.



Ecraseur.

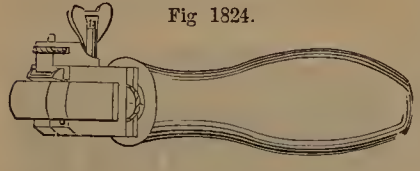
Ec-ty-pog'ra-phy. A mode of etching which gives the design in relief. The plate is exposed by the etching-needle between the lines, instead of at the lines.

Edge-cut'ting. The process of giving a smooth edge to books by cutting off the folds and making the margins of all the pages equal. The book is held in a *cutting-press* and the work done by a *plow* or *trimming-machine.*

Edge-joint. (*Carpentry.*) A joint formed by two edges, forming a corner.

Edge-mill. An ore-grinding or oil-mill in which the stones travel on their edges. In addition to the crushing action, the *edge-mill* has a frictional or grinding action, whose relative value may be considered as equal to the difference of distance performed by the inner and outer edges. See CHILIAN-MILL.

Fig 1824.



Edge-Plane for Shoe Soles.

Edge-plane. 1. (*Wood-working.*) A plane for edging boards, having a fence, and a face with the required shape ; flat, hollow, or round.

2. (*Shoe-making.*) A plane for shaving the edges of boot and shoe soles. It has a knife curved to the shape desired, a projecting edge which forms a guide and gage, and means for adjustment. The mouthpiece is adjustable, and holds the curved paring-knife by means of its jaws and set-screw.

Edg'er. A circular saw or pair of circular saws by which the bark and "*waney*" portions are ripped from slab-boards or boards made by ripping logs through and through, without squaring.

A double-edger has one permanent saw and one capable of regulation as to distance from the former one, so as to adapt the pair of saws to edge boards of varying width.

Edge-rail. (*Railroad.*) *a.* One form of railroad-rail, which bears the rolling stock on its edge. The rail is contradistinguished by its name from the *flat-rail*, which was first used ; the *angle-rail*, which succeeded that ; the *bridge-rail*, which presents an arched tread and has lateral flanged feet ; the *foot-rail*, which has a tread like the *edge-rail*, but, unlike it, has a broad base formed by foot flanges.

The first public railway laid with edge rails was made by Jessop of Loughborough, England, 1789. They were of cast-iron in 3 or 4 feet lengths, and had vertical holes near each end by which they were wooden-pinned to the sleepers. They were fish-bellied, and subsequently laid on cast-iron chairs.

Wyatt's patent in 1800 was an oval cast-iron rail. The upper surface was afterwards flattened.

Rolled-iron *edge-rails* were made in 1820 under Birkenshaw's patent.

See RAIL ; RAILWAY.

b. A rail placed by the side of the main rail at a switch to prevent the train from running off the track when the direction is changed.

Edge-roll. (*Bookbinding.*) A brass wheel, used hot, in running an edge ornament on a book cover, either gold or blind.

Edge-shot. A board with its edge planed is said to be *edge-shot.*

Edge-tool. (*Hardware.*) A general name which includes the heavier descriptions of cutting-tools, — axes, adzes, chisels, gouges, plane-bits.

Other cutting-tools come within the province of the armorer or cutler, and are included under *cutlery*, — knives, scissors, shears, surgical instruments, and, by the analogy of associated use, forks. See ADZE ; AXE ; HATCHET ; KNIFE.

The making of swords was anciently the work of the armorer, but has probably merged into *cutlery.*

Wood-cutting tools are divided by Holtzapffel as follows : —

1. *Paring* or *splitting* tools, with thin edges, the angle of the basil not exceeding 60° with the straight face. This includes *broad-axes, chisels, gouges*, etc.

Double-basil tools, such as *axes.*

2. *Scraping-tools* with thick edges, the angles measuring from 60° to 120°. These remove the fibers in the form of dust. The *veneer-scraper* is an instance. One angle of the edge of the steel plate is turned over to form a *bur*, known as a *wire-edge.*

3. *Shearing-tools ;* such are usually in pairs, acting from opposite sides of the object, the basil and face having an angle of from 60° to 90°.

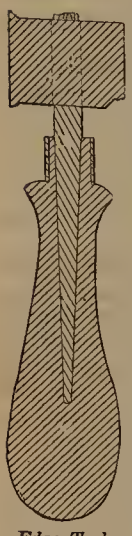
Iron and steel for edge-tools have been combined in a fagot and rolled so as to have a thickness of steel between layers of iron, for chopping-axes and some other tools, and with a layer of steel on one side for broadaxes, chisels, etc., which have but one basil. (Bouydell's patent, English.)

4. A burnisher for rubbing the edges of boot and shoe soles. See also EDGE-PLANE.

5. (*Saddlery.*) A tool used for removing the angular edge from a leathern strap.

For chamfering down the edges of a strap more broadly, another tool is used having a blade and

Fig 1825.



Edge-Tool.

guides which travel along the edge and face respectively of the leather. See CHAMFERING-TOOL.

Edge-wheel. A wheel traveling on its edge in a circular or annular bed, as in the ancient Phœnician oil-mills, the Chilian ore-mills, and many other crushing-mills. See CHILIAN MILL.

Edg'ing. The ornamentation of book edges by —

1. Color sprinkling.
2. MARBLING (which see).
3. Gilding.
4. Coloring; as the rubric style now so common.

Edg'ing-ma-chine'. A machine for edging boards to a given pattern. An *edger*.

Edg'ing-shears. A gardener's shears for trimming the edges of sod around walks or beds.

Edg'ing-tile. Tiles for borders of garden-beds, in place of grown edgings, such as box, thrift, etc. Such tiles for pleasure-gardens are made ornamental; for kitchen-gardens, plainer.

E-duc'tion-pipe. (*Steam-engine.*) The pipe which carries off the exhaust steam from the cylinder.

E-duc'tion-port. One through which the steam passes from the valves to the condenser. *Exhaust-port.*

E-dul'co-ra'tion. The effusion of water on any substance for the purpose of removing the portion soluble in that liquid. The article is usually agitated in water, which is removed by decantation after subsidence of the heavier portion.

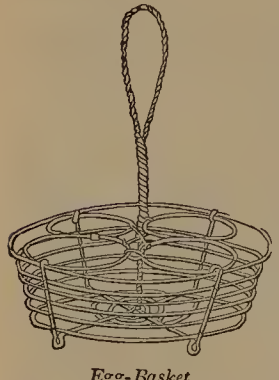
E-dul'co-ra'tor. A dropping-tube for applying small quantities of sweet solutions to a mixture.

Ef-fect'. The amount of work performed by a steam-engine or other machine. See DUTY.

Egg-as-sort'er. A device by which eggs are assorted according to quality; being so placed that a strong light is brought upon them when stuck into holes in a board, their comparative translucency is observed, and is accepted as an evidence of quality.

Egg-bas'ket. One for standing eggs in to boil, and also to hold them when placed on the table.

Fig. 1826.



Egg-Basket.

Egg-beat'er. A whip of wires or a set of wire loops rotated by gear while plunged in the egg contained in a bowl.

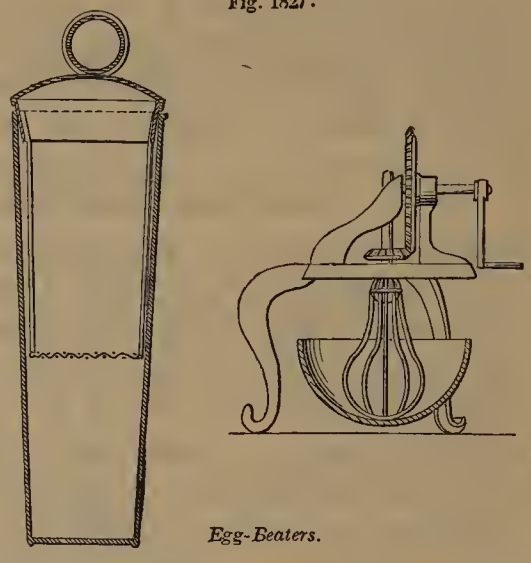
Another form is a vessel contained in another, and a wire gauze diaphragm through which the eggs pass when the vessels are reciprocated.

Egg-boil'er. A domestic device which sounds an alarm when the eggs have been exposed to the water a sufficient length of time to expand the water in the lower reservoir, raise the plug *d*, and release the trigger of the spring bell-hammer.

Egg-car'ri-er. A means for holding eggs in the proper carrying position without jolting against each other during transportation. The frames have cloth pockets for the eggs. In other forms the eggs are supported by pockets of wire or netting.

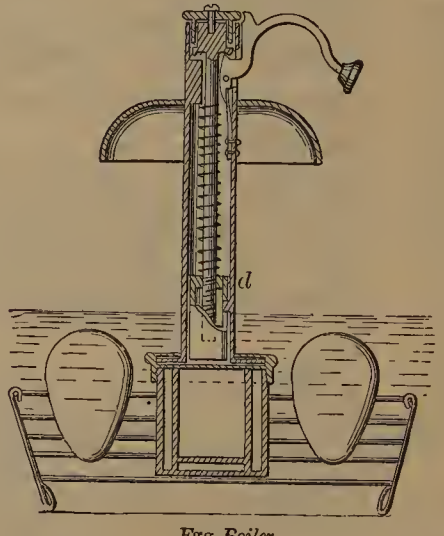
Egg-de-tect'or. An apparatus for showing the quality of eggs. They are placed upright in the holes in the lid of the dark chamber, and their transmitted light observed upon a mirror *C*; being viewed through a peep-hole, their quality is determined by their translucency as evinced by the relative transmission of light, as an egg becomes more cloudy and opaque as it becomes spoiled.

Fig. 1827.



Egg-Beaters.

Fig. 1828.



Egg-Boiler.

Fig. 1829.

Egg-Carrier.

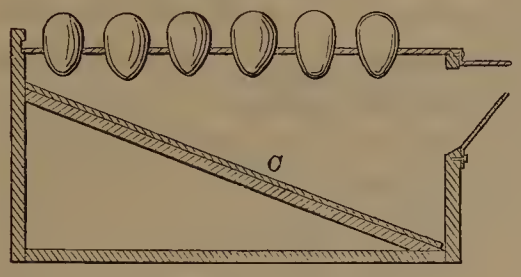
Egg-glass. 1. A glass for holding an egg while eating it.

2. A sand-glass running about three minutes, as a timist for egg-boiling.

Egg-hatch'ing Ap'pa-ra'tus. An apparatus for the artificial hatching of eggs. It has been practiced from time immemorial in Egypt. See INCUBATOR; CALORIFERE.

Egg-mold'ing; Egg and Tongue. (*Architecture.*) A peculiar molding in which a tongue de-

Fig. 1830.



Egg-Detector.

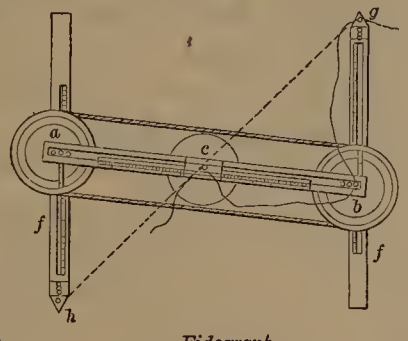
pendent from the corona alternates with an oval boss whose major diameter is vertical, like an egg set on end.

Egg-tongs. A grasping implement for seizing and holding an egg.

Fig. 1831.

Egg-Tongs.

Fig. 1832.



Eidograph.

Ei'do-graph. An instrument for copying drawing, invented by Professor Wallace. It consists of a central beam of mahogany, sliding backward and forward in a socket whose axis passes through a longitudinal slit in the beam.

Two equal wheels, one below each end of the beam, turn on axes that pass through pipes fixed at *a b*, near its extremities, and a steel chain passes over the wheels as a band by which motion may be communicated from one to the other. Two arms *f f* slide in sockets along the lower face of the wheels, just under their centers, one of which bears at its extremity *h* a metallic tracer, having a handle by which its point may be carried over the lines of any design, while at the extremity *g* of the other arm is a pencil, fixed in a metallic tube which slides in a pipe and is raised by a string, when required, the pressure on the paper being maintained by a weight.

The wheels being exactly equal in diameter, the arms attached to them, when once set parallel to each other, will remain so when the wheels are revolved.

For use, the instrument is set by sliding the central beam, so that the distance *b c* shall bear the same proportion to *a c* as the drawing to be copied is intended to bear to the copy.

The distances *b g*, *a h*, are also regulated to the same proportion. The center-piece and arms are graduated for this purpose, so as to admit of being set to any desired ratio.

Ei'do-scope. An instrument on the principle of the kaleidoscope, which produces an infinite variety of geometrical figures by the independent revolution of two perforated metallic disks on their axes. It may be employed in conjunction with the magic-lantern, when rapidly rotated causing flashing rays of light, forming singular combinations to appear upon the screen. Variously colored glass disks may be used, producing striking variations and combinations of color. — *Mechanical Magazine*, N. S., Vol. XVII. p. 35.

Eight-een'-mo. A book whose sheets are folded to form eighteen leaves. Sometimes written *octodecimo;* and usually indicated 18mo, or 18°.

Eight-line Pica. (*Printing.*) A type whose face has eight times the depth of pica. French, *double-canon.*

E-ject'or. 1. A device wherein a body of elastic fluid, such as steam or air, under pressure and in motion is made the means of driving a liquid such as water or oil. The effect of a body of escaping steam in setting liquids in motion was observed long since, but the most notable instance is the Giffard Injector (see INJECTOR), which is used as a feed-water pump for steam-boilers. The *ejector* acts on

Fig 1833.

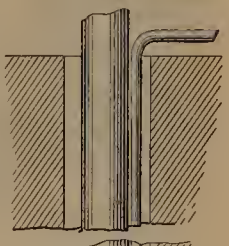
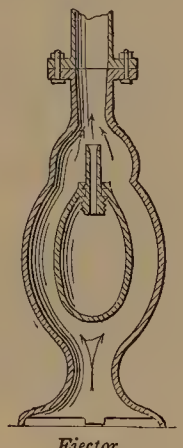
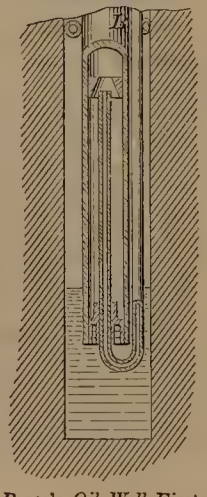


Fig. 1834.



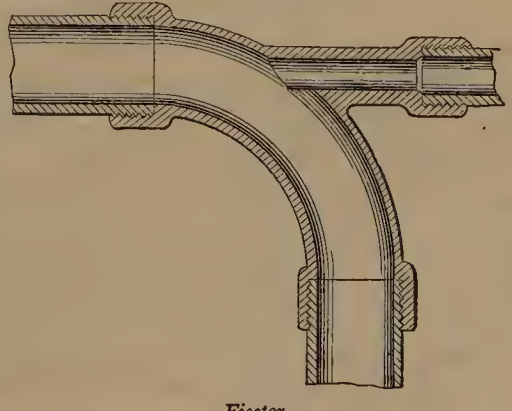
Ejector.



Pease's Oil-Well Ejector.

a similar principle, but is applied to *eject* or lift liquids, as in the example (Fig. 1833), where it is an oil-well pump. *B* is a pipe which proceeds from the surface of the ground to near the bottom of the well; its lower end is closed by a valve which opens upward. A steam-pipe passing down alongside the main pipe is recurved upwardly, and emits steam

Fig. 1835.



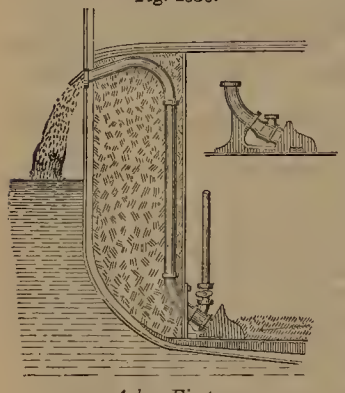
Ejector.

just in the throat of the contracted aperture. The effect is to draw up liquid by the force of the steam-

blast and carry it through the aperture, and so upwardly to the top. See also Figs. 59 to 64, inclusive.

Fig. 1834 is upon the same principle, the steam or air issuing through the small axial-pipe and passing into the up-cast pipe, drawing with it the liquid from the lower pipes which surround the ejector-nozzle.

Fig. 1836.



Ashes-Ejector

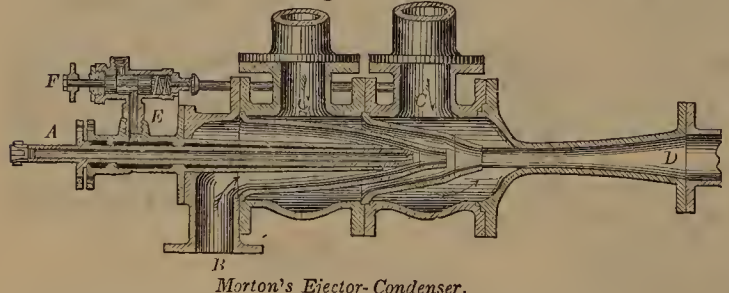
Fig. 1835 only differs in the mode of application, the bent pipe having an unobstructed passage in the nozzle for the admission of steam or air, communicating with the said passage on its back or outer curved side at a point directly opposite to and in line with the outlet or discharge opening.

2. That device in a breech-loading fire-arm which withdraws the empty cartridge-case from the bore of the gun.

3. A device on shipboard (Fig. 1836) for carrying up the ashes from the stoke-holes of steamships and discharging them overboard. The ashes are shoveled into a box, and a steam-jet being driven into the mouth-piece of the pipe causes an induced current of air which carries the ashes along with it, up the pipe, and overboard above the water-line.

E-ject'or-con-dens'er. (*Steam-engine.*) A form of condenser worked by the exhaust steam from the cylinder. In the example it is shown as applied to a pair of engines. The apparatus consists essentially of three concentric tubes terminating in conoidal nozzles, and opening into the hot-well or waste-water receptacle by a common and gradually

Fig. 1837.



Morton's Ejector-Condenser.

widening or trumpet-shaped mouth-piece *D*; the inlet-tube *B* is in communication with the water-tank from which the current of injection-water is obtained, while each of the other tubes *C* conveys the exhaust steam from one of the cylinders.

A is a regulating-spindle for adjusting the water-supply; *B*, the water-inlet; *C C*, the exhaust passages; *D*, the discharge passage; *E*, the steam-inlet; *F*, a self-adjusting steam-valve. In starting, steam is admitted at *E*, and passing along the axial-pipe, issues at the nozzle, drawing with it water from cold-water pipe *B*, which condenses the steam from the exhaust passages *C C* of the respective cylinders, and has momentum enough to carry the condensed steam and itself to the hot-well.

Eke'ing. (*Shipbuilding.*) *a.* A piece fitted to make good a deficiency in length on the lower part of the supporter under the cat-head, etc.

b. The piece of carved work under the lower end of the quarter-piece at the aft part of the quarter-gallery.

E'lai-om'e-ter. An instrument for detecting the adulteration of olive-oil.

E-las'tic-bulb Syr'inge. A syringe having a bulb of caoutchouc, whose expansion and contraction acts as a pump. See BREAST-PUMP; ATOMIZER.

E-las'tic Bands. Made of caoutchouc, naked or covered. The former are cut from flattened cylinders of rubber of proper diameter and thickness between a duplicate series of circular knives acting after the manner of shears; the latter are made by cutting continuous slips from a sheet of vulcanized rubber of the required thickness, wound upon a reel, by means of a knife with slide-rest motion. These strips are then covered with cotton or silk, and woven in an endless web. See CAOUTCHOUC.

E-las'tic-fab'ric Loom. One having mechanical devices for stretching the rubber threads or *shirrs*, and holding them at a positive tension while the fabric is woven.

E-las'tic Goods. Those having elastic cords, called *shirrs*, inserted in a fabric or between two thicknesses.

E-las'tic Mold. Elastic molds of glue for taking casts of *undercut* objects were invented by Douglas Fox, Derby, England.

The body to be molded is oiled and secured about an inch above the surface of a board, and is then surrounded by a wall of clay rather higher than itself, and about an inch distant from its periphery. Into this, warm melted glue, just fluid enough to run, is poured, completely enveloping the object. When cold, the clay wall is removed, and the mold delivered by cutting it into as many pieces as are required, either with a sharp knife or by threads previously placed in proper situations about the object. The pieces are then placed in their proper positions, and bound together. The mold is designed particularly for taking casts in plaster-of-paris, but molten wax, if not too hot, may also be employed.

E-las'tic Pis'ton-pump. A pump described in Dr. Gregory's "Mechanics" consists of an elastic bag provided with a valved board on top, and operating over a valved diaphragm. The trunk in which it operates is a square box, and the piston moves without friction against the trunk in which it works. The bag is of water-proof canvas or leather, with occasional rings.

A somewhat similar pump, recommended for a bilge-water pump, and for pumping out leak-water, is known as Cracknell's, and was somewhat famous in England forty years since. It had a pliable diaphragm of leather attached to the plunger-rod, and a valve on top like the pump just described. As the leather diaphragm was driven down and drawn up alternately, it filled with water and then lifted it, the lower valve rising as the plunger lifted. See BAG-PUMP.

E-las'tic Pro-pel'ler. A form of ship's propeller invented by Macintosh, in which the blades are of flexible steel, which assume a more and more nearly disk form as the speed and consequent resistance of the water is increased.

E-las'tic Type. Type made of compounds of caoutchouc, which will accommodate themselves to a somewhat uneven surface in printing, and in which a form of said type may be lapped around a curved printing-surface.

E-lat'er-om'e-ter. A pressure-gage for air or steam.

El'bow. 1. The junction of two parts having a bent joint. A *knee* or *toggle* joint. An abrupt angle.

2. A bend, as of a stove-pipe, a wall, a parapet.

3. A support for the arm, elbow high, as the arm of a chair.

4. A voussoir of an arch which also forms part of a horizontal course. An obtuse angle of a wall.

5. (*Joinery.*) The sides or flanks of a paneled recess; especially the two small pieces of framing which occur on each side of a window immediately below the shutters when the window-jambs are carried down to the floor, forming a slight recess.

El'bow-board. (*Carpentry.*) The board at the bottom of a window on which the elbows of a person are supported when leaning.

El'bow-tongs. A crucible tongs with jaws bent between the joint and chaps.

E'lec-trep'e-ter. An instrument for changing the direction of electric currents.

E-lec'tri-cal Ap'pa-ra'tus. Gilbert, in his book "De Magnete," 1600, first introduces into the nomenclature of the sciences the word "electric," deriving it from *electron* (Gr. *amber*), which was the only substance known to the ancients that acquired the property of attracting light bodies when rubbed. He gives a list of bodies, as diamond, sapphire, crystal, glass, sulphur, sealing-wax, and others, possessing the electric property, which he very properly distinguishes from magnetic power, the former attracting all light bodies, the latter iron only. He regarded magnetism and electricity as two emanations of one fundamental force. He considered the earth as a magnet, and the lines of equal declination and inclination as having their inflections determined by distribution of mass, or by the forms of continents and by the extent of the deep intervening oceanic basins. Gilbert was surgeon to Queen Elizabeth and James I., and died in 1603.

The electric-telegraph preceded the electro-magnetic by many years. See ELECTRIC-TELEGRAPH.

Otto Guericke, of Magdeburg, discovered that there was a repulsive as well as an attractive force in electricity, observing that a globe of sulphur, after attracting a feather to it, repelled it until the feather had again been placed in contact with some other substance. Newton, in 1675, observed signs of electrical excitement in a rubbed plate of glass. Hawkesbee, who wrote in 1709, also observed similar phenomena; and Dufay in the "Memoirs of the French Academy," between 1733 and 1737, generalized so far as to lay down the principle that electric bodies attract all those which are not so, and repel them as soon as they have become electric by the vicinity or contact of the electric body.

Dufay also discovered that a body electrified by contact with a resinous substance repelled another electrified in a similar way, and attracted one which had been electrified by contact with glass.

He thence concluded that the electricity derived from those two sources was of different kinds, and applied the names vitreous and resinous to them. Franklin attributed this difference to an excess or deficiency of the electric fluid, the former condition existing in electrified glass and the latter in resins.

Otto Guericke had observed that his sulphur globe, when rubbed in a dark place, emitted faint flashes of light, and shortly afterward it was noticed that a similar phenomenon occurred at the surface of the mercury when the barometer was shaken; a fact which one of the celebrated mathematicians, Bernoulli, attempted to explain on the Cartesian system, but which was afterwards correctly attributed by Hawkesbee to electricity. Wall, in 1708, observed the sparks produced from amber, and Hawkesbee noticed the sparks and "snapping" under various modifications.

Dufay and the Abbé Nollet were the first to draw sparks from the human body; an experiment which attracted great attention, and became a species of fashionable diversion at the time.

The discovery of the Leyden jar is attributed to Cunœus of Leyden, in 1746, who, while handling a vessel containing water in communication with an electrical machine, was surprised at receiving a severe shock; a similar event had happened the year previous to Von Kleinst, a German prelate.

Gray in 1729 discovered that certain substances were possessed of a conductive in contradistinction to an electric power; and afterwards Nollet passed a shock through a circle of 180 men of the French guards, and along a line of men and wires 900 toises in length, while Watson in England ascertained that the transmission of the shock through 12,000 feet of wire was sensibly instantaneous.

Franklin in 1747 pointed out the circumstances on which the action of the Leyden jar depends, showing that the inside is positively and the outside negatively electrified, and that the shock is produced by the restoration of the equilibrium when communication is established between them. Monnier the younger discovered that the electricity which bodies can receive depends on their surface rather than their mass, and Franklin soon found that "the whole force of the bottle and power of giving a shock is in the glass itself"; he farther, in 1750, suggested that electricity and lightning were identical in their nature, and in 1752 demonstrated this fact by means of his kite and key; about the same time D'Alibard and others in France erected a pointed rod forty feet high at Marli, for the purpose of verifying Franklin's theory, which was found to give sparks on the passage of a thunder-cloud. Similar experiments were repeated throughout Europe, and in 1753 Richman was instantly killed at St. Petersburg by a discharge from a rod of this kind.

The more important discoveries since those days relate rather to electricity produced by voltaic or magnetic action. See, under the following heads: —

E-lec'tri-cal and Mag-net'i-cal Ap-pli'-an-ces.

Annunciator.
Anode.
Armature.
Astatic needle.
Battery.
Calorimotor.
Carbon-battery.
Catelectrode.
Cathode.
Cell.
Circuit.
Circuit-breaker.
Circuit-closer.
Commutator.
Compound battery.
Condenser. Electric
Conductor.
Constant battery.
Couple.
Current-regulator.
De Luc's column.
Dip.
Dipping-needle.
Discharging-rod.
Doubler.
Dry-pile.
Earth-battery.
Earth-plate.
Electrepeter.
Electrical apparatus.
Electric alarm.
Electrical machine.
Electric annunciator.
Electric balance.
Electric battery.
Electric bridge.
Electric cable.
Electric clock.
Electric escapement.
Electric fuse.
Electric governor.
Electric harpoon.
Electric heater.
Electric helix.
Electric indicator.
Electric lamp.
Electric light.
Electric log.

Electric loom.
Electric meter.
Electric pendulum.
Electric piano.
Electric railway-signal.
Electric regulator.
Electric signal.
Electric steam-gage.
Electric switch.
Electric telegraph.
Electric time-ball.
Electric torch.
Electric wand.
Electric weighing-apparatus.
Electric whaling-apparatus.
Electro-ballistic apparatus.
Electro-blasting.
Electro-chemical telegraph.
Electro-chronograph.
Electrode.
Electro-dynamic engine.
Electro-engraving.
Electro-etching.
Electro-gilding.
Electrolyte.
Electro-magnet.
Electro-magnetic clock.
Electro-magnetic engine.
Electro-magnetic machine.
Electro-magnetic regulator.
Electro-magnetic telegraph.
Electro-magnetic watch-clock.
Electro-medical battery.
Electrometer.
Electro-motor.
Electro-negative.
Electronome.
Electrophorus.
Electro-plating.
Electro-positive.
Electro-puncturing.
Electroscope.
Electrotint.
Electrotype.
Filings-separator.
Galvanic battery.
Galvanizing-iron.
Galvanography.
Galvanometer.
Galvanometric multiplier.
Galvanoplastic process.
Galvanoscope.
Geisler-tube.
Hydro-electric machine.
Inclinatorium.
Inclinometer.
Induction apparatus.
Induction coil.
Inductometer.
Insulated wire.
Insulating-stool.
Insulator.
Inversor.
Leyden battery.
Leyden jar.
Lighting gas by electricity.
Lightning-arrester.
Lightning-conductor.
Lightning-rod.
Line-wire.
Magnet.
Magnetic battery.
Magnetic compensator.
Magnetic curative-appliances.
Magnetic guard.
Magnetic hone.
Magnetic needle.
Magneto-electric apparatus.
Magneto-electric machine.
Magneto-electric telegraph.
Magnetograph.
Magnetometer.
Manipulator.
Mariner's compass.
Meteorometer.
Multiplier.
Negative.
Organ. Electric
Pantelegraph.
Paragrandine.
Paragrele.
Pendulum. Electric
Pile.
Polarized armature.
Pole.
Positive.
Prime-conductor.
Receiving-magnet.
Reel-telegraph.
Relay-magnet.
Repeater.
Resistance-box.
Resistance-coil.
Rheometer.
Rheomotor.
Rheophone.
Rheoscope.
Rheostat.
Rheotome.
Rheotrope.
Rubber.
Ruhmkorff battery.
Sideroscope.
Signal-box.
Sounder.
Submarine-cable.
Switch.
Telegraph (varieties, see TELEGRAPH).
Telegraph-cable.
Telegraph-clock.
Telegraphic signal.
Telegraph-indicator.
Telegraph-instrument.
Telegraph-key.
Telegraph-wire.
Terminal.
Thermo-electric pile.
Torsion-balance.
Torsion-electrometer.
Trough.
Unit-jar.
Variation-compass.
Volta-electrometer.
Voltaic battery.
Voltaic light.
Voltaic pile.
Voltameter.
Voltaplast.
Voltatype.
Zambonis-pile.

E-lec'tric A-larm'. An instrument, otherwise known as a *thermostat*, used for giving an alarm when the temperature rises to a point at which the instrument completes the circuit. This is used in stoves and hot-houses, to indicate excess or lack of temperature, and as a maximum thermometer-alarum or fire-alarm, which is made by carrying one platinum wire in connection with a battery and bell into the bulb of a mercurial thermometer, and another wire down the tube to the degree it is not desired to exceed. When the mercury rises to this point, the circuit is completed, and notice is given by the ringing of the bell. One form of the minimum temperature alarm consists of a spirit-thermometer, the bulb of which is placed above and the tube curved in a U-shape. A platinum wire is carried into the bulb and down to the degree of heat it is wished to notify. Below this minimum the curvature is filled with mercury, which is in free communication with a second platinum wire. As the alcohol contracts with the cold, the mercury will, of course, rise, and, reaching the first platinum wire, complete the circuit and give the warning. One bell and the same battery will serve for the two thermometers; but it will be necessary to interpose a commutator to ascertain through which circuit the current is passing, and whether a rise or fall is indicated when the bell is rung.

Fire-alarms constructed on the same principle are placed in different apartments of a building, the increased temperature in that where fire happens to first break out expands a wire or column of mercury, which, by completing a circuit, sounds an alarm. The most compact form of the thermostat is that resembling the chronometer-balance. See THERMOSTAT; FIRE-ALARM.

E-lec'tri-cal Ma-chine'. An apparatus for generating, or rather collecting or exciting, electricity by means of friction.

The Greeks were aware that amber, when rubbed, acquired the power of attracting and repelling light bodies; and for many ages this property was supposed to be peculiar to amber, from the Greek name of which (ἤλεκτρον) the word "electricity" was derived. It was subsequently discovered that the same effect was produced by resinous substances rubbed with flannel, and by glass when rubbed with silk; and our readers may have noticed that by stroking a cat's back smartly with the hand in clear frosty weather, a crackling noise accompanied by a tingling sensation is produced.

Substances in the condition referred to are said to be electrically excited. This excitement is termed positive if glass be the material employed, and negative if resin be used; the kind of electricity developed by each substance having a tendency to attract that derived from the other, and to repel that of the same kind as itself. According to the theory of Dufay, the two kinds were called vitreous and resinous; the former being derived from glass and corresponding to the positive of Franklin, and the latter from resin, corresponding to the negative. It is by the latter terms, positive or +, and negative or —, that the two kinds are now universally known. See *supra*, page 777.

In machines for developing frictional electricity in quantities, glass is the material employed, either in the form of a hollow cylinder rounded at the ends or of a circular plate. These are rotated in contact with a leather-covered cushion, upon the surface of which a thin layer of an amalgam composed of tin,

zinc, and mercury is spread, and a suspended flap or apron of silk.

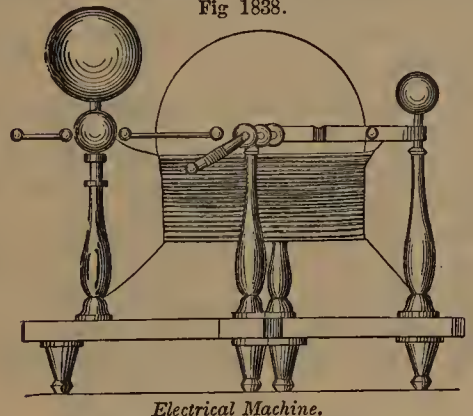
Gilbert, in 1600, conjectured the fundamental identity of the forces known as magnetism and electricity, and measured the strength of the electricity excited by rubbing amber, glass, resin, etc. His elcctrometer was an iron needle poised on a pivot.

Otto Guericke, of Magdeburg, recognized phenomena of repulsion. "He heard the first sound and saw the first light in artificially excited electricity." Newton saw the first traces of an "electric charge" in 1675, in some experiment with a rubbed plate of glass.

Although Wall in 1708, Gray in 1734, and Nollet, conjectured the identity of frictional electricity and lightning, yet Franklin was the first to attain the experimental certainty by his well-known kite experiment in 1752.

Electrical machines were formerly made cylindrical, but are now more frequently made with a circular glass disk rotated by a hand-crank. The glass passes between rubbing surfaces, and the electric current

Fig 1838.



Electrical Machine.

which is generated passes to the conductors on each edge of the disk, and thence to the prime conductor, when it passes to a Leyden jar or other object, as may be desired. The plate-machine of the University of Mississippi has two plates each 6 feet in diameter. One made for the London Polytechnic Institute has a plate 10 feet in diameter driven by a steam-engine of 4-horse power.

See Deschanel's "Natural Philosophy," Part III. pp. 533–545.

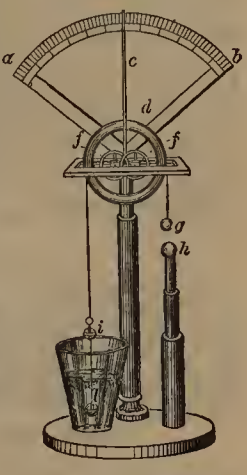
E-lec'tric An-nun'ci-a'tor. A form of annunciator in which a circuit wire is the means of shifting the shield covering the number aperture on the dial, or performing other duty to expose the number of the room. The guest in his room touches a stud upon the wall; the circuit being made or broken, the effect is evidenced by the exposure of the room number in the hotel-office. It is an electromagnetic expedient as a substitute for a pulling wire. See ANNUNCIATOR.

E-lec'tric Bal'ance. An instrument for measuring the attractive or repulsive forces of electrified bodies. A form of electrometer.

It consists of a graduated arc *a b* supported by a projecting plate of brass which is attached to the perpendicular column. A wheel *d*, the axis of which is supported on anti-friction rollers *f f*, and is concentric with that of the graduated arc *a b*, carries an index *c*.

Over this wheel, in a groove on its circumference, passes a line, to one end of which is attached a light ball of gilt wood *g*, and to the other a float *i l*, which consists of a glass tube about two tenths of an inch in diameter, terminating in a small bulb *l* at its lower end, which contains a small portion of mercury or some very fine shot, put into it for the purpose of adjusting the instrument, so that the index *c* may point to the zero division or center of the graduated arc. The difference between the weights of the float when in and out of water is known, and the diameter of the wheel carrying the index is such that a certain amount of rise or fall of the float causes the index to move over a certain number of graduations on the arc. The body whose electricity is to be measured is presented at *h*, and its attractive or repulsive power on the ball *g* is estimated by the rising or falling of the float in the fluid, and consequent motion of the index *c*, as shown by the graduated arc.

Fig. 1839.



Electric Balance.

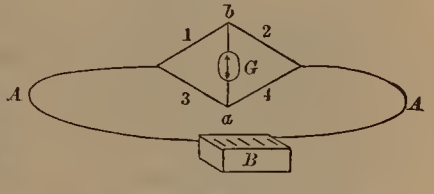
When the attractive force of the two bodies is to be estimated, the line passing over the wheel *d* must be formed of two parts, the lower part being of silver thread and the remainder of silk; when their repulsive force is to be estimated, the whole is of silk. See ELECTROMETER; GALVANOMETER.

E-lec'tric Bat'ter-y. A series of Leyden jars having all their interior and exterior coated surfaces connected with each other by means of conductors, so that the accumulated electricity of the whole may be made to act together, resembling the effects of lightning itself.

A large battery of this kind is capable of polarizing bars of iron or steel, and instantaneously melting iron or tin wire into globules, which are dispersed in all directions, the fusion of the latter metal being accompanied by a cloud of blue smoke, a dazzling flash, and a loud report. Small animals are killed by it, and a violent shock given to the human system. See LEYDEN-JAR.

E-lec'tric Bridge. (*Electricity.*) A term applied to an arrangement of electrical circuits used for measuring the resistance of an element of the circuit. The most generally known and used are the Wheatstone "bridge" or "balance," and that of the British Association. The former in substantial respects is adopted in the Siemen's universal galvanometer, in such general use.

Fig. 1840.



Electric Bridge.

The principle involved is that an electrical circuit being divided into two branch-circuits, and again united, and the branches "bridged" or connected by a "short cut," if the resistances in the branches on one side of the "bridge" are in the same ratio to each other as the resistances on the other side, no current will traverse the "bridge"; if the ratios are not equal, a current will traverse the bridge.

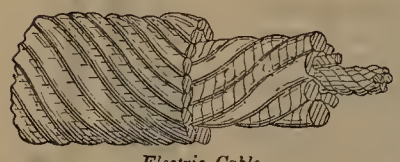
A A, metallic circuit from battery *B* divided into branches 1, 2, and 3, 4, which again unite. Calling resistance "R," when R 1 : R 3 : : R 2 : R 4,

an equilibrium or "balance" is established, and there is no appreciable current in the "bridge" *a b*, in which is inserted the galvanometer *G*.

In use, the resistance of one of the members, say 4, being known, the unknown resistance is inserted in 2 and its resistance calculated from the deflections of the needle in the galvanometer, caused by the current thrown through the "bridge." See DUPLEX-TELEGRAPH.

E-lec'tric Ca'ble. Various forms of telegraph cable for submarine uses have been proposed. That between England and Ireland is composed of a single copper wire covered with gutta-percha, surrounded by hempen yarn, and the whole protected by ten No. 8 iron wires twisted. That between Dover and Calais has four copper wires covered with gutta-percha twisted into a rope, and protected in similar manner. It weighs seven, and the Irish two, tons to the mile. The first Atlantic cable was composed of seven No. 22 copper wires, covered with gutta-percha, hempen yarn, and an outside coating of iron wire. This weighed 19 cwt. to the mile. The cut shows a cable with coils diversely twisted. See TELEGRAPH CABLE.

Fig. 1841.



Electric Cable.

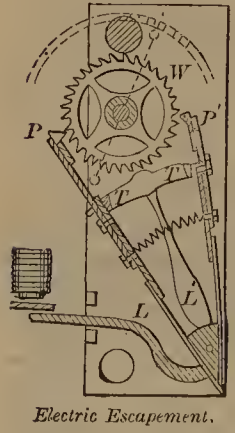
E-lec'tric Clock. A dial with hands and going-train impelled by recurrent impulses from an electro-magnet. The first known clock of this kind was invented by Wheatstone and exhibited by him in 1840. Appold, Bain, Shepherd, and others have contrived clocks on the same principle. See ELECTRO-MAGNETIC CLOCK.

E-lec'tric Es-cape'ment. A device actuated by electric impulse which intermittingly arrests the motion of the scape-wheel and restrains the train to a pulsative motion, — acting, in fact, in the place of a pendulum. An electric pendulum at a central station may be the regulator of numerous distant clocks with electric escapements, with each of which it is connected by circuit or circuits. In some cases the device has alternately a detent and impulse action, and is the motor as well as regulator.

Devices in which a train is set in motion, or a machine started or stopped, are not strictly escapements, but may be considered as *electrical-governors* or *electrical-regulators*.

In that illustrated, the lever *L* and its corresponding one on the opposite side, not shown, are caused to vibrate to the action of the circuit; these cause the anchor-shaped piece *L' T T* to strike alternately against each of the pallets *P P'*, which are fastened by springs, and yield in either direction, so as to alternately retain and release the scape-wheel *W*.

Fig. 1842.



Electric Escapement.

E-lec'tric Fuse. A device used in blasting to explode the charge. The fulminate or the charge itself is lighted by means of an electric spark or a resistance section of fine platinum wire, which is heated to redness by the passage of an electric current induced by a voltaic or magneto-electric battery. See FUSE.

E-lec'tric Gov'ern-or. One in which a part of a fly-wheel, say a segment of the rim, is made to move radially outward when the wheel revolves at a rate above a preappointed speed, and thereby comes in contact with a metallic tongue completing an electric connection, which is utilized to move a butterfly-valve or other device which concerns the transmission of power.

Governor-balls flying out to a certain distance may make or break an electric connection to produce the same result, or sound an alarm.

Electro-magnetic action is also used to start and stop machines, and operate stop-motions.

E-lec'tric Har-poon'. An application of the electric force to the explosion of a bursting-charge in a harpoon or bomb-lance. A copper wire is carried through the line, and, when a circuit is established by the harpooner, a resistance-section in the fuse of the bomb-lance ignites the charge. See HARPOON; BOMB-LANCE.

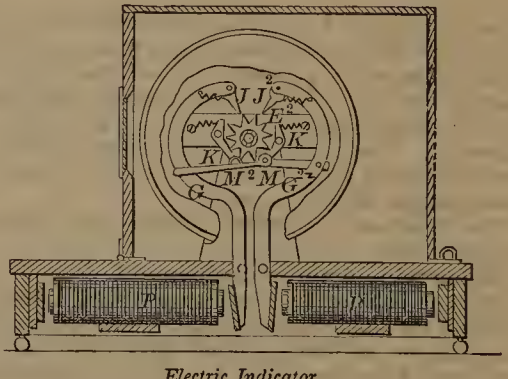
E-lec'tric Heat'er. A device in which a fine platinum wire heated by a passing electric current is made to communicate sensible heat as a means of warming or burning, as the case may be. It has been used as a local cautery, has been suggested for amputating, and for some other purpose, which it would excite a smile to name.

It is a lower application of the same principle as is developed in the electric light; a body of relatively great resistance is included in a circuit, and, failing to carry the electricity, a part of the latter takes the form of heat.

E-lec'tric He'lix. A coil of copper wire around a bar of soft iron; the coil forms part of an electric circuit, and confers polarity upon the iron. The two constitute an electro-magnet.

E-lec'tric In'di-ca'tor. The apparatus shown in Fig. 1843 is for indicating electro-magnetic cur-

Fig. 1843.



Electric Indicator.

rents, and consists of a wheel having figures upon its periphery turned by a star-wheel E^2 upon its shaft. The star-wheel is actuated by pawls *J J K K*, connected with armature levers *G* G^2 turning one cog, equal to one figure, at each completion of the circuit through one of the spool-magnets *P P*. The two magnets are arranged to cause opposite rotation, and either may be connected with the operating-key by a switch. The circuit passes through the axis of the key and through numbered buttons upon a disk. The key being brought in contact with a button causes one movement of the numbered wheel, and each time the key comes in contact with a button the wheel is moved one figure, and no more.

E-lec'tric Lamp. A box or case provided with an electric lighting-apparatus. See ELECTRIC LIGHT.

E-lec'tric Light. An intense light generated by

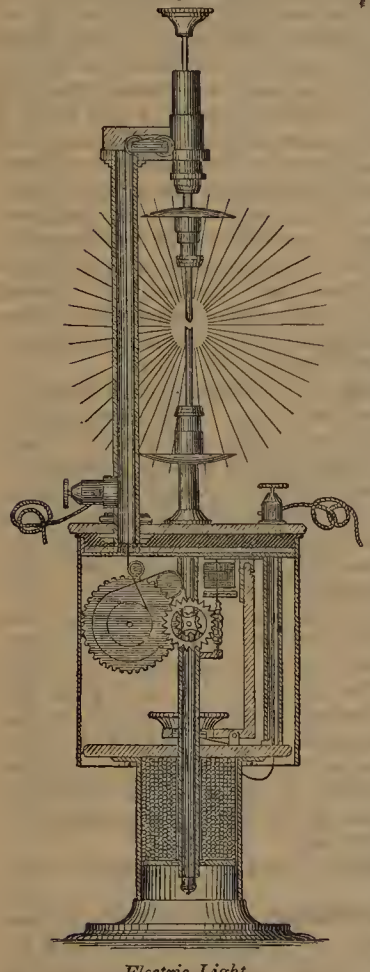
passing an electric current between two pieces of charcoal fixed at the positive and negative ends of the circuit.

The electricity developed may be either derived from voltaic action or from magnets in connection with a series of helixes arranged on a rotating wheel, the latter source being preferred for practical application to illuminating purposes.

The lights of the natural lanterns carried by fireflies, glow-worms, and some species of nocturnal moths, may be considered as *electric* lights. Though classed as phosphorescent, some of them are intermittent, and we suppose the nervous action by which they are flashed into brilliancy to be in the nature of what we call a voltaic impulse from the battery, — the brain.

The electric light was first brought into notice in 1846. The patent of Greener and Staite of that year embraced an arrangement whereby small lumps of pure carbon, inclosed in air-tight vessels, were rendered luminous by currents of galvanic electricity. Two small cylinders or bits of pure carbon were placed nearly in contact with their points toward each other, and maintained at a constantly equal distance apart by means of clockwork, which slowly advanced them as they were consumed by combustion. Through these the current of a galvanic battery was transmitted, so that the circuit would not be complete without traversing the small space between the points of the two pieces of carbon; this generated an intense heat at this spot, causing the combustion of the carbon, which was accompanied by an extremely brilliant light. The chief practical difficulty was found to be in maintaining the points at such a distance from each other as to render the light continuous instead of intermittent.

Fig 1844.



Electric Light

This is now effected by means of an electro-magnet and a clock movement, the duty of the latter being to bring the two points together as they are gradually worn away by the passage of the electric current, while the former checks the clock action when not required. The positive carbon pencil is found to wear much more rapidly than the negative; and in order to maintain the point where the light is produced at a uniform elevation, the cord by which each point is advanced is caused to pass around a barrel, larger for the positive and smaller for the negative, so as to take up unequal quantities of cord.

When the battery employed is very powerful, the electricity between the points assumes the form of an arc of dazzling brilliancy. With 600 Bunsen's cells arranged consecutively, an arc 7.8 inches in length was obtained; and when the 600 cells were arranged in six parallel series, a still more powerful light was produced.

According to Fizeau and Foucault, the intensity of the electric light with a battery of 46 pairs of Bunsen burners was 235, that of the sun being taken at 1,000, while with 80 pairs it was but 238.

During the excavation of the docks at Cherbourg two apparatus of this kind were employed, maintained by a single battery of 50 pairs of Bunsen, affording sufficient light for 800 workmen.

The magneto-electric light was applied for illuminating the lighthouse at Dungeness, England, in 1862, and was introduced at La Hève, France, a year or two later. The machines employed at each are very similar in construction and entirely so in principle, the English apparatus being arranged after the following manner: —

Eighty-eight bobbins or coils of copper wire are wound about an equal number of cores of soft iron, and arranged in two parallel rings, forty-four in each ring, at the circumference of a wheel 5 feet in diameter, their axes being parallel to that of the wheel. The axes of each set are placed midway between those of the other. Sixty-six powerful horse-shoe magnets are firmly fixed in three rings exterior to the wheel and parallel to each other, twenty-two in each ring, their poles being in the planes of their respective rings, and distant from each other a space equal to that which separates the centers of the bobbins.

The magnets of the several rings are similarly situated upon the circumference, their poles being alternate; but the poles of those in the inner and outer rings face contrary poles in the central ring.

As the wheel is turned, which is effected by connection from a steam-engine working at a power of one and a half to two horses, the cores with their bobbins pass between the successive poles of the fixed magnets, and as the spaces between the bobbins are equal to those between the poles of the magnets, all the bobbins of one ring pass the poles simultaneously; but as these are arranged intermediately between those of the other ring, it follows that while one set of bobbins is passing the poles the other set is half-way between them; thus alternate currents of opposite character are generated in each set of bobbins, the polarity being changed at the moment of polar passage, so that while the current in one set of bobbins is in the middle of its flow the other undergoes a sudden reversal.

By means, however, of "commutators," all the successively opposite currents are turned in the same direction in the circuit which conveys the electricity to the carbon points; any fluctuations in the strength of the currents are thus compensated so as to render the resulting intensity very nearly constant. The velocity of rotation imparted to the wheel is about 110 turns per minute, causing nearly 10,000 changes of polarity in that time. The intensity of the light produced depends on the velocity of rotation, being comparatively feeble at a slow speed and increasing up to a certain point, when an acceleration of the velocity seems rather to diminish than increase the light.

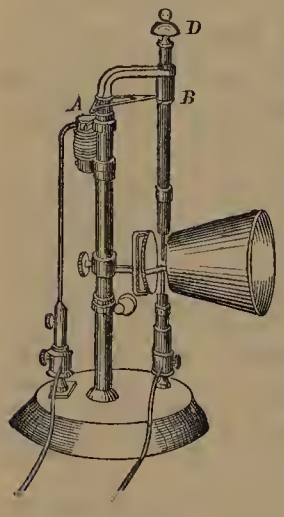
In the French machine, sixty-four bobbins are

arranged in four sets, and revolve between five sets of magnets, eight in a set. They are so arranged as to pass the poles of the magnets simultaneously, and a commutator is dispensed with. This arrangement, by making each of the carbon points alternately the positive and negative poles of the circuit, insures their equal wear, and permits the use of a simpler apparatus for maintaining a uniform distance between them.

The apparatus actually employed at La Hève lighthouse comprised two of the above machines, each driven by a separate engine, affording a light equivalent to 3,500 Carcel burners, or more than six times that of an oil light of a similar class. Its fog-penetrating power is said to be very superior to that of the latter.

In Browning's electric light, worked by a battery of six Grove cells, the principle adopted is to let the carbon points touch each other, and to clamp them in that position, so that the current has to burn an interval between the two points for itself. In the accompanying cut, *D* is a brass rod carrying the upper carbon point, and sliding easily in its vertical bearings by its own weight. Directly the upper point touches the lower one, the current is established, and the little electro-magnet *A* at once pulls down its armature, which clamps the upper brass rod at *B*. Directly the current is broken by the wasting away of the carbons, the electro-magnet *A* ceases to hold the brass rod, which then falls, and re-establishes the communication.

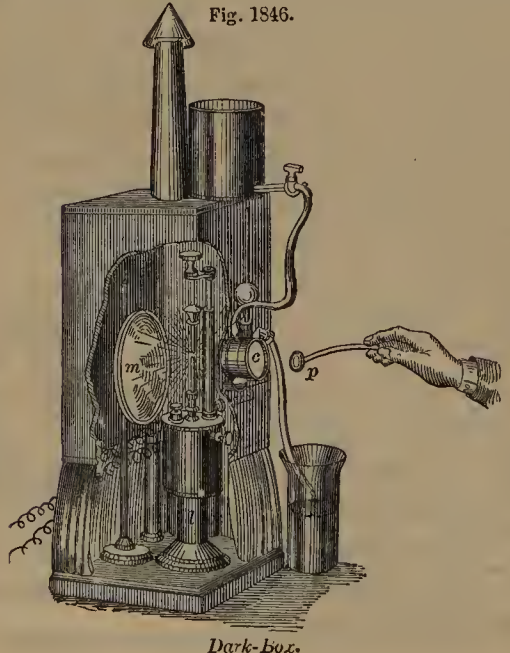
Fig. 1845.



Browning's Electric Light.

Professor Tyndal, in his experiments, concealed the electric light in what he termed a *dark-box*, in order that all the issuing beams may be emitted at one orifice, and the experiments be the more vivid in the absence of diffused light in the room. *l* is the electric lamp, the rays of which are focused at any desired point. The apparatus is adapted for a large range of experiments, but in the figure is shown with Tyndal's *ray-filter c*, in which the luminous rays are filtered out by passing the beam through an opaque solution of iodine in bisulphide of carbon, while the invisible heating or ultra-red rays are transmitted. A current of cool water circulates in the jacket on the outside of the cell to keep the volatile bisulphide cool. *p* represents a piece of blackened platinum held in the focus of the mirror to be heated to redness by the invisible heat-rays, although no light passes out through the solution.

Fig. 1846.



Dark-box.

The electric light on the Victoria tower of the British Houses of Parliament at Westminster is generated by a Gramme magneto-electric machine, driven by an engine in a vault of the House of Commons, and connected with the signaling-point by two copper wires half an inch in diameter and 900 feet long. The machine consists of a permanent horseshoe-magnet, between the poles of which revolves an electro-magnet, consisting of a ring of soft iron round which is wound an insulated conducting wire, continuous, but disposed in sections. The light apparatus is placed within a lantern 5 feet high, 4 feet wide, and having a semicircular glass front, and the light may be directed in a horizontal arc of 180°. Two lamps are used alternately, the carbon-points lasting four hours. Expense, twenty cents per hour.

E-lec'tric Log. An electric circuit through the log-line to the detent of an escapement in the register-log, so that by touching a key on deck a circuit may be completed, an armature attracted, and thus the starting and stopping of the mechanical register in the log be exactly timed. See LOG.

E-lec'tric Loom. In 1852 an electric loom was exhibited by Bonelli at Turin. The invention was at that time in a crude state, but has since been much improved. The object is to dispense with the perforated cards required in the Jacquard apparatus. For this purpose, an endless band of paper covered with tin-foil is used, on which the required pattern is traced with a varnish, rendering the parts thus covered nonconducting.

This band is caused to pass under a series of thin metallic teeth, each connected with a small electro-magnet, which operate a series of pistons that open or close the holes in a perforated metallic plate (answering to the Jacquard card), through which pass the needles governing the hooks by which the warp-threads are lifted or let fall, according as the electro-maguets are in action by contact of the teeth with the metallic surface of the band, or inoperative by contact with the varnish.

E-lec'tric Me'ter. See ELECTROMETER; ELECTROSCOPE.

E-lec'tric Pen'du-lum. The ordinary element of an electric clock. A point below the bob of the pendulum passes through a globule of mercury, the time of contact being indicated on a traveling fillet of paper. In another form the bob comes in contact, at the limit of each stroke, with a delicate spring, which makes the electric connection.

Besides its use as a chronograph for recording atmospheric, astronomical, and other observations, it is also employed to secure isochronous beats of distant pendulums. A mode of keeping distant chronometers in exact simultaneous pulsation by which longitude may be exactly determined; the invention of Dr. John Locke of Cincinnati.

E-lec'tric Pi-a'no. One provided with a series of electro-magnets, each corresponding to a key of

the instrument, the armatures of which are caused to strike the keys when the circuit is closed. This may be effected by means of perforated cards through which pins are caused to pass and again retracted in any required sequence, after the manner of the Jacquard apparatus. The device may be connected with a number of instruments at great distances apart, so that they may be caused to play the same tune simultaneously.

In 1868, a contrivance on this principle for playing the organ was exhibited in London. It was operated by means of a keyboard, and by enabling the performer to be placed at some distance from the instrument it was claimed that he was better able to judge of its tones, so as to play with more effect.

E-lec'tric Rail'way-sig'nal. A device for communicating messages or warnings as to the place or condition of a train on the track, in regard to stations left or approached, or to other trains on the same line.

1. An automatic signal operated by the wheel on the track to indicate the passage of a given point by a train, to signal the approach to a crossing in advance; or to the rear, to show the distance of a preceding train; or to signal to a station the position of trains on a track.

2. To enable an operator on a car to communicate with a station at a distance, or with an observer or operator on another train on the same line.

3. To communicate between parts of the same train, as between the conductor and engineer, etc.

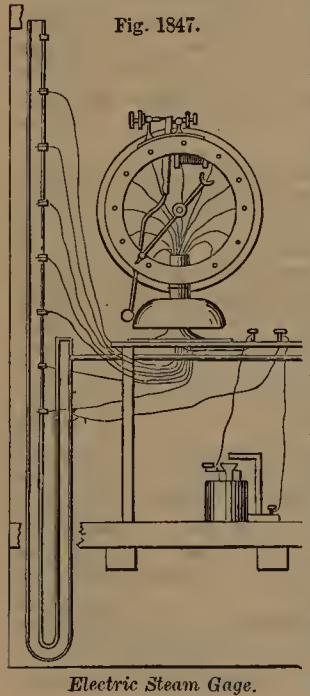
E-lec'tric Reg'u-la'tor. A device by which an electro-magnetic circuit is made the means of reaching a machine to stop it or start it. The applications are numerous and various.

In gas-lighting by electricity, the gas-cock at a distance is turned by a succession of impulses derived from a battery, communicated through a wire circuit, and imparted to an armature connected with the plug or valve.

As a means of controlling machinery at a distance, the electric circuit, by its magnetic power, affords means for putting a detent into action or removing it.

Stop motions in machinery are also made effective by electric connection, as, for instance, in spinning and knitting machines, when the breaking of a thread allows a metallic arm to drop, and this comes in contact with a tongue, and makes a connection which turns a band on to a loose pulley or otherwise.

Fig. 1847.



Electric Steam Gage.

E-lec'tric Sig'nal. One in which visual, palpable, or audible signals, by simple or repetitive sounds or by code, are conveyed by electric influence. The motion of bell-hammers, of flags, index-fingers, or semaphoric arms may be held as included in this definition, which thus covers telegraphing and signaling by electric circuit.

By a not distant connection, storm-signals and time-balls of observatories may be held as included.

E-lec'tric Steam-gage. A steam-boiler attachment, in which the rise of the mercury under pressure of steam is indicated by means of electric connection to the dial. In the example, the galvanic battery and index are connected with the mercury column by means of insulated points on the tube, so that the index will signal each successive pound of pressure upon the dial, which has corresponding points. The completion of the circuit also sounds an alarm by attracting the armature on the hammer-shaft.

E-lec'tric Switch. A device for interrupting or dividing one circuit and transferring the current or a part of it to another circuit. See SWITCH. A *commutator*. See Culley's "Handbook of Telegraphy," London, 1870, pp. 199–203.

E-lec'tric Tel'e-graph. That form of electric signaling apparatus in which an insulated wire excited by frictional electricity is — or rather was — used to convey messages by sparks or shocks. For notices of early observations, see ELECTRICAL APPARATUS.

Gray, in 1729, experimented with conductors; Nollet soon afterwards sent a shock along a line of men and wires 900 toises in length; Watson, the learned Bishop of Llandaff, in 1745, sent a shock through 12,000 feet of wire, and proved that it was practically instantaneous throughout its length. He signaled an observer by this means.

A writer in the "Scots' Magazine," in 1753, proposed a series of wires from the ends of which were to be suspended light balls marked with the letters of the alphabet, or bells which were to be moved by an electric current directed to the appropriate wire.

Lesage, at Geneva, in 1774, actually constructed a telegraph arranged in this manner, the end of each wire having a pith-ball electroscope attached.

Lamond, in 1787, employed a single wire, employing an electrical machine and electroscope in each of two rooms, and thus talking with Madame Lamond by the peculiar movements of the pith-balls according to an agreed code; and Reusser, in 1794, proposed the employment of letters formed by spaces cut out of parallel strips of tin-foil pasted on sheets of glass, which would appear luminous on the passage of the electric spark.

In 1795, Cavallo proposed to transmit letters and numbers by a combination of sparks and pauses.

Don Silva, in Spain, appears to have previously suggested a similar process. See ELECTRICAL APPARATUS.

In 1816, Mr. Ronalds experimented with a frictional electricity telegraph at Hammersmith. The current had to pass through eight miles of wire, and the signals were made by means of light pith-balls. The reading was effected by dials at each station having a synchronous movement derived from clockwork. Upon their circumferences the letters of the alphabet were engraved, and a screen with a hole cut through it was arranged at each end of the line, so that only one letter should be visible at a time. The operator at the transmitting station waited until the letter he wanted came opposite the hole in the screen and then made the signal, causing the divergence of the pith-balls at the instant that the same letter became visible to the observer at the other station through the aperture in his screen.

Betancourt, in 1796, constructed a single-line telegraph between Madrid and Aranjuez, a distance of twenty-seven miles, in which the electricity was furnished by a battery of Leyden jars, and the reading effected by the divergence of pith-balls.

It was not, however, until the discoveries of Volta, Galvani, Oersted, Ampere, Faraday, and Henry elucidated the properties of electricity de-

veloped by the voltaic battery, that a practical, continuously working instrument was feasible. Following these discoveries came the practical instruments and codes of the no less illustrious Morse, Wheatstone, and others. See VOLTAIC PILE; GALVANIC BATTERY; ELECTRO-MAGNETIC TELEGRAPH.

E-lec'tric Time-ball. A balloon of canvas suspended on a mast, and dropped at an exact time every day by means of an electric circuit operated by an observer whose eye is upon the astronomical clock, and hand upon the telegraph-key.

E-lec'tric Torch. A gas-lighter operating by electric action. An *electrophorus*.

E-lec'tric Wand. An electrophorus in the shape of a baton. See ELECTROPHORUS.

E-lec'tric Watch-clock. A watchman's time-detector, in which a patrol touches a stud at such times during the night as may indicate his presence at that spot at the appointed hour. Touching the stud completes an electric connection and makes a mark upon a traveling time-paper.

E-lec'tric Weigh'ing-ap'pa-ra'tus. An attachment to a scale which comes in as an auxiliary to the eye in detecting the turn of the scale. The poise is shifted out on the beam, and as soon as it feels the tendency to rise the circuit is completed, and the point at which the poise stopped is indicated.

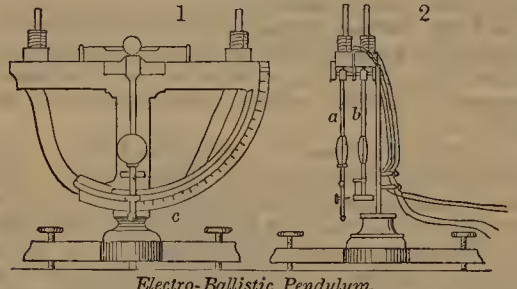
E-lec'tric Whal'ing-ap'pa-ra'tus. A means whereby a bursting-charge in a harpoon may be exploded. See ELECTRIC HARPOON.

E-lec'tro-bal-lis'tic Ap'pa-ra'tus. An instrument for determining by electricity the velocity of a projectile at any part of its flight.

The projectile passes through a wire screen, thus breaking a current of electricity, and setting in motion a pendulum, which is arrested on the passage of the projectile through a second screen. The distance between the screens being known, the arc through which the pendulum vibrates measures the time due to the projectile's flight between the screens. See CHRONOGRAPH; BALLISTIC PENDULUM.

E-lec'tro-bal-lis'tic Pen'du-lum. Fig. 1848 1 is an elevation and 2 a section of the appa-

Fig. 1848.



Electro-Ballistic Pendulum.

ratus used in the United States Ordnance Department. The pendulums *a b* are suspended from the same axis, and are so adjusted that when each is brought to a horizontal position at the 90° mark on each side of zero at the middle of the arc *c* and let fall, they will meet precisely at the center. The bob of the inner pendulum *b* is provided with a marking point, the outer end of which is struck by a blunt projection on the outer pendulum *a*, when the two pass each other, impressing a mark on a sheet of paper clamped to the arc. See CHRONOGRAPH.

E-lec'tro-blast'ing. Blasting by means of an electric or electro-magnetic battery, communicating through connecting wires with the charges of powder.

It was first tried in blowing up the sunken hull of the "Royal George," in 1839, by Colonel Pasley.

In 1840 the plan was used in Boston Harbor by Captain Paris.

In 1843, by Cubitt, for overthrowing a large section of Round-down Cliff, Kent, England, in making a portion of the Southeastern Railway. The mass dislodged weighed 400,000 tons. See BLASTING.

E-lec'tro-chem'i-cal Tel'e-graph. A telegraph which records signals upon paper imbued with a chemical solution, which is discharged or caused to change color by electric action.

Nicholson and Carlisle discovered, in 1800, that water was decomposed by the voltaic pile, hydrogen being evolved at the negative and oxygen at the positive end of the wire. Davy, afterwards Sir Humphry Davy, by the aid of the apparatus of the Royal Institution at London, the most powerful then in existence, proved by a series of experiments, commencing in 1801, that many substances hitherto considered as elementary bodies could be decomposed by voltaic action, and succeeded in 1807 in resolving the fixed alkalies soda and potash. Faraday, 1833, besides his extensive additions to the science of electro-magnetism, established the fact that the chemical power of a current of electricity is in direct proportion to the absolute quantity of electricity which passes; and farther proved that the quantities required for decomposing compound bodies were proportional to the atomic weights of Dalton.

Bain's telegraph (1845) was the first in which these scientific facts were so applied as to lead to any practical result.

In this, a solution of ferro-cyanide of potassium in water, to which are added two parts of nitric acid and two of water, is employed. With this long strips of paper are saturated, which being drawn between a metallic roller and stylus operated by means usual in electro-telegraphy, — dispensing, however, with relay-magnets, — dots and dashes are produced, as in the Morse system. These appear of a blue color, in consequence of the ferro-cyanide of potassium being converted into cyanide of iron by electric action and contact of the iron stylus with the paper.

Bakewell subsequently improved the construction of this instrument, and added an electro-magnetic governor, to obtain synchronism in the movements of the apparatus at the two ends of the line.

Gintl, a German, in his method, also dispenses with the relay, and records messages by the line-current direct. He prepares his paper with a solution of one part iodide potassium and twenty starch-paste in forty parts of water. The iodine being set free colors the starch blue.

Bonelli's telegraph (1860) records a fac-simile of the transmitted message on mechanically prepared paper. The message is set up in type, which are arranged in a box at one side of a carriage that traverses from end to end of a table, and passes back and forth under a bridge placed transversely thereto. The type occupy the lower left-hand side of the carriage, and at the upper right-hand side is placed a strip of the paper. Immediately over the type are five movable teeth, insulated from each other and connected by five wires with a similar number of styles at the receiving apparatus. As the carriage with the types face upwards comes under the bridge, the teeth come lightly in contact with their raised portions, closing the circuit so long as the metallic contact lasts. Thus letter after letter is transmitted. On the right side of the bridge is a writing-comb composed of five teeth made of platinum-iridium alloy, which is not subject to corrosion, insulated from each other and pressing lightly on the paper strip beneath. This would produce, if each tooth were simultaneously

traversed by the electric current, five parallel lines on the paper; but as the current only passes to each during the time when some portion of a type is beneath the corresponding tooth of the type-comb at the sending station, they only produce lines at such intervals and of such length as are determined by the form of the type; cavities in the letters and spaces between letters and words being represented by the discontinuation of one or more of the lines.

The wagon is moved by a cord and weight, and is secured at one end of the carriage by a hook, which is released by an electro-magnet when a current is sent over the wires.

Those at each end of the line are adjusted to traverse their respective carriages in equal or nearly equal times.

The paper intended for receiving permanent printing is prepared by being saturated in a solution of nitrate of manganese, which, under the action of the current, leaves a light brown mark. Fugitive printing, as for the press, is done on paper prepared with iodide of potassium, which affords at first an iodine color, but is liable to fade.

It is said that a speed of 300 in permanent, and of 1200 words in fugitive, printing per minute is attainable by this apparatus. See ELECTRO-MAGNETIC TELEGRAPH: AUTOGRAPHIC TELEGRAPH.

E-lec'tro-chron'o-graph. An instrument used for recording time and occurrences in the instant and order of their time, as in noting transits in observatories. A paper marked for seconds is placed on the surface of a revolving drum, over which is a stylus operated by electro-magnetic action when the circuit is closed by the telegraph key in the hand of the operator, who is also the observer at the transit instrument. A mark is thus made on the time-paper at the instant of the occurrence of the transit.

E-lec'trode. Either of the poles of the voltaic circle. The positive, +, electrode is the *anode;* the negative, −, the *cathode.* The terms are Faraday's.

E-lec'tro-dy-nam'ic En'gine. An engine in which a dynamic effect is produced by the evolution of an electric current, by voltaic battery or otherwise. See ELECTRO-MAGNETIC MACHINE.

E-lec'tro-en-grav'ing. Engraving executed by means of electricity. A form of etching.

E-lec'tro-etch'ing. A process for biting-in an engraving by attaching it to the copper of the battery in an electro-bath. The plate is covered with a ground and etched in the usual manner; being immersed for a while in the bath, it is withdrawn and the fine lines *stopped-out;* a second immersion deepens the lines and makes the next tint, and so on.

E-lec'tro-gild'ing. A thin deposition of gold by voltaic action on an object placed in a bath of a salt of the metal. See ELECTRO-PLATING.

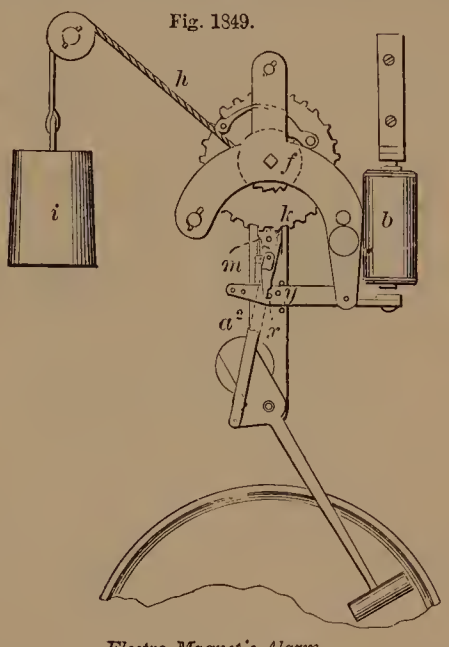
E-lec'tro-lyte. The compound in the electro-plating bath which is decomposed by the electric action.

E-lec'tro-mag'net. A bar of soft iron rendered temporarily magnetic by the passage of a current of electricity through a coil of wire by which the bar is surrounded.

The electro-magnet of the Stevens Institute of Technology weighs in all about 1,600 pounds; eight brass spools, each of which is wound with 272 coils of copper wire insulated with *kerite.* The hollow spools contain cores of Norway iron, four to each core. The lifting-force of the magnet is from thirty to fifty tons.

E-lec'tro-mag-net'ic A-larm'. One which is brought into action by the closing an electro-magnetic circuit. This may be a burglar-alarm in which the opening of a door or window is made to close a circuit mechanically; or it may be a fire-alarm in which the lengthening of a rod or a change in its shape is made to close a circuit. In some cases, a column of mercury is expanded by the heat and thus completes the circuit, the coil *b* attracting the armature and releasing the detent of the wheel *k*, which is then revolved by the weight *i* and cord *h*, and

Fig. 1349.



Electro-Magnetic Alarm.

vibrates the hammer-shaft, delivering a blow upon the bell. By this means the hammer may be made to give a repetitive alarm, like that of a clock, as a warning, or the instrument may be used as a signal, each closing of the circuit by means of a key giving a single blow. See FIRE-ALARM.

E-lec'tro-mag-net'ic Clock. These clocks are of two kinds: —

Those in which the motive-power is derived from electric action. Invented by Wheatstone.

Those which are operated by the usual means, but are made the medium by mechanical devices of driving or regulating other clocks to which they are connected by an electric circuit.

1. In Bain's clock the pendulum, at each vibration, moves a light slide by which the electric circuit is alternately completed and broken, and by which magnetism is alternately conferred upon and abstracted from a coil inclosed in a heavy hollow brass case which constitutes the bob of the pendulum. On either side of the pendulum are the poles of two permanent magnets, which alternately attract and repel the coil of the bob, according to its magnetized or demagnetized condition.

A clock of this kind has been kept in motion by electric currents derived from a zinc plate buried in damp earth.

Shepherd's electro-magnetic clock was shown at the London Exposition, 1851. In this clock electro-magnetism is the sole motor in moving the pendulum, driving the train, and running the striking-works, no weights or auxiliary springs being employed.

The pendulum in its oscillations makes and breaks an electric circuit, which alternately magnetizes and demagnetizes a horseshoe-magnet, which in its active condition attracts an armature and raises a lever which is caught by a detent-latch. On the break-

ing of the circuit, the armature is released, the latch lifted, and the weighted lever strikes the pendulum to give an adequate impulse to maintain its motion. This is repeated at each oscillation.

Besides the circuit just described, which maintains its own action, the pendulum makes and unmakes another circuit which actuates a ratchet-wheel, propelling it at the rate of a tooth to each second, the axis of this ratchet-wheel operating the remainder of the train.

The circuit of the *striking* part is only completed once in an hour, and operates an armature to pull the ratchet-wheel attached to the notched striking-wheel one tooth forward every two seconds, and each tooth is accompanied by a blow on an electro-magnetic bell. The number of blows depends upon the notched wheel, the spaces in the circumference of which are adapted to the number to be struck; and when this is complete, a lever falls into the notch, and in so doing cuts off the electric circuit till the recurrent period again stirs the striking-parts into activity.

2. The other form of electro-magnetic clock is designed to obtain isochronous action among a number of clocks in different portions of a building or a town.

Fixed upon the arbor or axis of the second-wheel of a clock is a wheel of metal, the circumference of which is divided into sixty alternating divisions of metal and of ivory, the former being a conductor and the latter a nonconductor of electricity. A small platinum peg is kept in contact with this divided edge, so as, by the revolution of the wheel, to be alternately in contact with the conducting and nonconducting surfaces, and so connected with a voltaic series as to alternately admit and resist the passage of an electric current.

The electric circuit thus becoming pulsative is caused by local magnets and armatures to actuate an apparatus stationed at any point to which the wires may be carried, giving motion to a wheel and axle, and causing it to revolve so as to indicate seconds, and the other motion-work of a clock.

By this means isochronous pulsations of seconds are maintained at all the points connected with the regulator, and thus perfect uniformity is established at all the clocks of a city, capitol, or private establishment.

Dr. Locke of Cincinnati, about 1848, invented the method of obtaining isochronous vibration of pendulums by electric connection. Congress awarded him a premium of $10,000 for the invention, designing to use it in astronomical researches and determining longitudes.

E-lec'tro-mag-net'ic En'gine. The action of a current of electricity converts a piece of soft bar-iron into a magnet, and the breaking of the circuit restores the iron to an inert condition. This transition — alternate excitement and prostration — has been frequently utilized to confer a pulsative movement upon an armature, whose motion in one direction is obtained by the attraction of the magnet and the reflex action by a spring or weight in the intervals of electric excitement of the iron.

So far the chronicler has little to record of valuable effect derived from this engine, though its power is demonstrable. At present the authorities declare it is resolved into a question of the relative costs of zinc and coal. The case is thus stated in the "American Artisan": —

"The chemical action in the galvanic battery is the source of power in electro-magnetic engines, just as the rapid chemical action called combustion in the furnace of a steam-engine is the source of power there. Chemical affinity, or the tendency of two bodies to combine chemically, is a sort of potential energy which, when the substances actually do combine, is replaced by actual energy in the form of heat or of current electricity, or of both combined; and this may be converted into mechanical energy. In a Daniells battery, the liquid in the cells being a solution of a sulphate of copper in water, the total heat produced by the solution of one pound of zinc is 3,006 thermal units; 2,342 being produced by the oxidation of the zinc, and 664 being produced by the combination of the oxide of zinc with sulphuric acid. The total heat consumed is 1,419 thermal units; 527 being consumed in decomposing sulphate of oxide of copper, and 1,060 being consumed in decomposing the oxide of copper. The total quantity of heat developed is, therefore, 3,006 less 1,587, equal to 1,419 thermal units; and this quantity multiplied by 772 foot-pounds, the mechanical equivalent of heat, gives 1,095,468 foot-pounds for the amount of energy developed by the solution of one pound of zinc in a Daniells battery. This is less than the total energy developed by the combustion of one pound of carbon. In a Smee's battery, the liquid in the cells being dilute sulphuric acid, the heat produced by the combination of one pound of zinc with oxygen and sulphuric acid is, as before, 3,006 thermal units, and the total heat consumed is 2,106 thermal units; about 200 being consumed in separating water from sulphuric acid, and 1,906 being consumed in decomposing water. The total amount of heat developed, therefore, is 3,206 less 2,106, equal to 900 thermal units, which are equivalent to 694,800 foot-pounds of mechanical energy derived from the solution of one pound of zinc in a Smee's battery. This is about one sixteenth part of the energy developed by burning one pound of carbon. It is certain that the *efficiency* can be made to approximate much more nearly to *unity*, the limit of perfection, in electro-magnetic engines than in steam-engines. At present, however, the ratio of their efficiencies can only be roughly estimated; and it may be considered as a favorable view toward electro-magnetic engines to estimate their greatest possible efficiency as four times that of the best steam-engines. Taking this into account along with the previous calculations, and it appears that the work performed per pound of zinc may be estimated at four tenths of the work per pound of carbon in steam-engines when the solution used in the cells of the battery is sulphate of copper; and at four sixteenths, or one fourth, of the work per pound of carbon in steam-engines when dilute sulphuric acid is used in the cells of the battery.

"Before, therefore, electro-magnetic engines can become equally economical with heat engines as to cost of working, their working expense per pound of zinc consumed must fall until it is from four tenths to one quarter of the working expense of one of the most economical steam-engines per pound of carbon or of coal equivalent to carbon. The price of zinc, however, being so much greater than that of coal, it is evident from these facts and calculations that electro-magnetic engines never can come into general use except in cases where the power required is so small that the cost of material consumed is of no practical importance, and the situation of the machinery is such as to make it very desirable to have a prime mover without a furnace."

According to Mr. Joule, the consumption of a grain of zinc, though forty times more costly than a grain of coal, produces only about one eighth of the same mechanical effect.

Cazal's electro-magnetic machine resembles a fly-wheel, being a thick disk of soft iron cut into the

shape of a gear-wheel and having a circumferential groove wound with insulated wire, whose ends are soldered to insulated thimbles, which, by means of tangent springs, introduce the battery current. Surrounding this magnetic wheel is a fixed, heavy iron ring insulated on its interior surface in a manner to present elevations corresponding to the teeth of the wheel. When the teeth of the wheel pass before the prominences of the ring, there is a near approach to contact, and the attraction is strong. The attractions are balanced when the teeth are midway. At the moment of nearest approach the current is arrested; it is renewed when the teeth are midway; the momentum of the wheel carries it over the point of equal attractions.

The Birmingham Company's (English) electro-motor has four sets of fixed electro-magnets of the horseshoe form, two sets at each end of an oscillating beam by which the power is to be utilized. The magnets of each set are arranged in two tiers, one above the other. The armatures of these several magnets are carried by rods depending from the ends of the beam; but the rods pass freely through these armatures without being fastened to them. When, therefore, an armature, in the descent of the rod, comes into contact with the magnet to which it belongs, the rod continues its motion and leaves the armature resting there. In the return motion the rod lifts the armature again, by means of a collar or enlargement which has been given to it at the place intended.

In the action of the machine, the battery current actuates the magnets on the side of the descent, while on the other side the current is cut off. The machine acts, therefore, only by attraction. As the armatures approach their magnets successively, it happens that whenever one becomes inefficient, by coming into contact with its magnet, the next will be in position to exert a very high attractive force, and this force increases until this next makes contact with its magnet in like manner.

Kravogl's electro-magnetic engine is a heavy wrought-iron wheel rotated by the creeping up inside it of a permanent magnet, which displaces the center of gravity, and by the preponderance of the side rotates the wheel.

Another form of the engine has two powerful helixes of insulated copper wire, within which are two heavy cylinders of soft iron counterbalanced on the ends of a beam, like the working beam of a steam-engine. By the working of an eccentric on the main or fly-wheel shaft these insulated helixes are alternately connected and disconnected with the opposite sides of a galvanic battery so as to magnetize and demagnetize alternately the two helixes, and so drawing first one and then the other of the soft bar-iron cylinders into them with a force of many hundred pounds. In some machines of this description 10-horse power has been obtained.

Page's reciprocating engine (Fig. 1850) consisted of two electro-magnets, the armatures of which are connected by a bar moving upon centers, the bar is connected with the beam, which, by means of a crank, moves the fly-wheel; by means of a break-piece upon the axle of the fly-wheel, the current is alternately passed through the two magnets.

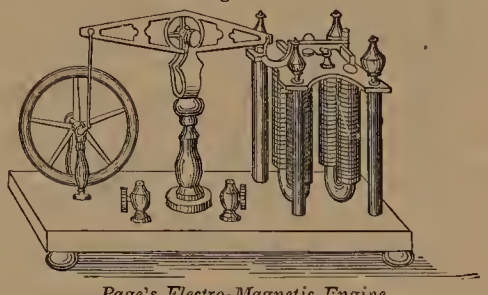
A double-beam engine of similar construction, operated by two pairs of electro-magnets, has also been made.

About 1849, Professor Page propelled a car on the track of the Baltimore and Washington Railroad from Washington to Bladensburg, a distance of six miles, and back, by means of an engine of his invention, attaining a speed of nineteen miles an hour.

Various forms of electro-magnetic engines have also been invented by Wheatstone, Talbot, Hearder, Hjorth, and others. Professor Jacobi of St. Petersburg, in 1838 – 39, succeeded in propelling a boat upon the Neva at the rate of four miles an hour, by means of a machine on this principle. The boat was 28 feet long, about 7 feet wide, drew about 3 feet water. The battery used consisted of sixty-four pairs of plates, and propelled the boat by paddle-wheels. He also applied his engine to working machinery, but without decided success.

In 1842, Davidson constructed an electro-magnetic locomotive-engine which attained a speed of about four miles an hour on the Edinburgh and Glasgow Railway.

Fig. 1850.



Page's Electro-Magnetic Engine.

E-lec'tro-mag-net'ic Ma-chine'. See ELECTRO-MAGNETIC ENGINE.

E-lec'tro-mag-net'ic Reg'u-la-tor. A device for maintaining an even heat in an apartment, a bath, or a furnace. See THERMOSTAT.

E-lec'tro-mag-net'ic Tel'e-graph. A signaling, writing, printing, or recording apparatus in which the impulses proceed from a magnetic force developed by voltaic electricity. A mass of soft iron is rendered temporarily magnetic by the passage of a current of electricity through a surrounding coil of wire. It differs from the *electric telegraph* properly considered, and also, specifically, from the MAGNETO-ELECTRIC TELEGRAPH (which see). See also list under TELEGRAPH.

Three discoveries necessarily preceded the invention of the electro-magnetic telegraph: the properties of the magnet, the modes of developing frictional electricity, and voltaic electricity. The earlier electric telegraphs were all what their name implies, and not *electro-magnetic*. See ELECTRIC TELEGRAPH.

To save repetition, reference is here made to MAGNET, ELECTRICITY, ELECTRIC TELEGRAPH, VOLTAIC PILE, GALVANIC BATTERY, for the precedent discoveries and inventions which are the foundation of the electro-magnetic telegraph.

In 1808, Sömmering described a system invented by him, based upon the decomposition of water by the voltaic pile, embracing a number of wires equal to that of the alphabet and the numerals, and leading into glass tubes containing water, the bubbles of gas from which, when the electric fluid was conducted into them, served as signals.

Professor Coxe, of Pennsylvania, about the same time suggested telegraphing by means of the decomposition of metallic salts.

Oersted, in 1820, after many years' research into the action of the voltaic current on magnets, announced the fact that the magnetic needle was deflected by such current, exhibiting a tendency to place itself at right angles to the wire through which the current passes; and Faraday discovered in 1821 that the magnet would revolve about the conducting wire, or the latter about the magnet.

The experiments of Oersted, farther extended by Ampère, and the discovery by Faraday that magnetism was induced in a bar of soft iron under the influence of a voltaic circuit, led the way to the invention of the first really convenient and practical system of electro-telegraphy.

In 1825, Mr. Sturgeon, of London, discovered that a soft iron bar, surrounded by a helix of wire, through which a voltaic current is passed, becomes magnetized, and continues so as long as the current is passing through the wire.

In 1832, Baron Schilling constructed a model of a telegraph which was to give signals by the deflection of a needle to the right or left.

One great practical difficulty was still to be overcome, the resistance of the transmitting wire to the comparatively feeble current engendered by the voltaic battery.

This was conquered by Professor Joseph Henry, now secretary of the Smithsonian Institution at Washington, who, in 1831, invented the form of magnet now generally used for telegraphic purposes, and discovered the principle of "*combination of circuits*, constituting the important invention of *receiving-magnet*, and the *relay* or *local battery*, as they are familiarly known in connection with Morse's telegraph. The effect of a combination of circuits is to enable a weak or exhausted current to bring into action and substitute for itself a fresh and powerful one. This is an essential condition to obtaining useful mechanical results from electricity itself, where a long circuit of conductors is used." — Prescott, *History of the Electric Telegraph*.

In 1832, Professor Morse began to devote his attention to the subject of telegraphy; and in that year, while on his passage home from Europe, invented the form of telegraph since so well known as "Morse's."

A short line worked on his plan was set up in 1835, though it was not until June 20, 1840, that he obtained his first patent, and nearly four years elapsed before means could be procured, which were finally granted by the government of the United States, to test its practical working over a line of any length; though he had as early as 1837 endeavored to induce Congress to appropriate a sum of money sufficient to construct a line between Washington and Baltimore.

Professor Morse deserves high honor for the ingenious manner in which he availed himself of scientific discoveries previously made by others, for many important discoveries of his own, and for the courage and perseverance which he manifested, in endeavoring to render his system of practical utility to mankind by bringing it prominently to the notice of the public; and he lived to see it adopted in its essential features throughout the civilized world.

In the mean while Gauss and Weber, and after them Steinheil, in Germany, were at work, and constructed a short line between the Royal Academy at Munich and the observatory; this, by means of right and left hand deflection-needles, was caused to print dots on a continuous slip of paper, moved by clock-work.

While making experiments in connection with this work, Steinheil made the important discovery that the earth might be used as a part of the circuit, thus enabling him to dispense with one half the length of wire which was thought requisite.

The attention of Wheatstone, in England, appears to have been drawn to the subject of telegraphy in 1834.

Morse's first idea was to employ chemical agencies for recording the signals, but he subsequently abandoned this for an apparatus which simply marked on strips of paper the dots and dashes composing his alphabet. The paper itself is now generally dispensed with, at least in this country, and the signals read by sound, — a practice which conduces to accuracy in transmission, as the ear is found less liable to mistake the duration and succession of sounds than the eye to read a series of marks on paper.

Bain, in 1846, patented the electro-chemical telegraph which dispensed with the relay-magnet at intermediate stations; and subsequently Gintl, in Austria, and Bonelli, constructed telegraphs of this class, varying in details from that of Bain. See Electro-chemical Telegraph.

Wheatstone's first telegraph comprised five pointing needles and as many line wires, requiring the deflection of two of the needles to indicate each letter.

His first dial instrument was patented in 1840; modifications were, however, subsequently made in it. The transmission of messages was effected by a wheel having fifteen teeth and as many inter-spaces, each representing a letter of the alphabet or a numeral, and thirty spokes corresponding to these, and forming a part of the line. The circuit was closed by two diametrically opposite springs, so arranged that when one was in contact with a tooth the other was opposite a space, when the transmitter was turned until opposite a particular letter, and held there, a continuous current being produced, causing an index on the indicating dial at the other end of the line, which had thirty divisions, corresponding to those of the transmitter, to turn until it arrived opposite the letter to be indicated. The revolution of the index was effected by clock-work, the escapement of which was actuated by an electro-magnet at either end of a pivoted beam, the ends of which carried two soft-iron armatures. One of the line wires, as well as one of the contact springs of the transmitter, and one of the electro-magnets of the indicator, was afterwards dispensed with.

A magneto-electric apparatus was subsequently substituted for the voltaic battery.

The single-needle telegraph of Cook and Wheatstone is caused to indicate the letters and figures by means of the deflections to the right or left of a vertical pointer; for instance, the letter A is indicated by two deflections to the left, N by two deflections to the right, I by three consecutive deflections to the right, and then one to the left, and so on. This is extensively employed in Great Britain and in India.

The same inventors have also contrived a double needle-telegraph on the same plan; but this, as it requires two lines of wire, each needle being independent of the other, though greatly increasing the speed with which messages may be transmitted, has not come into general use.

Dr. Siemens, of Berlin, invented an apparatus by which the armatures of the electro-magnets at each end of the line were caused to vibrate synchronously, maintaining the motion of scape-wheels carrying pointers traversing a lettered dial, so that, the vibrations of either armature being checked, the pointers at either end of the line would simultaneously point to the same letter.

House, about 1845, invented a telegraph which printed the letters of the Roman alphabet on a strip of paper, and was at one time extensively used in the United States. It comprised a lettered disk, operated in much the same way as that of Wheatstone, from keys arranged like those of a piano, and a receiving-apparatus, which included a scape-wheel, an anchor escapement, controlled by the movements of the lettered disk, and actuating a slide-valve which operated the piston of a compressed-air cylinder by

which a wheel carrying type on its periphery was turned so as to present the appropriate letter indicated at the transmitting station to the paper slip which was by suitable mechanism drawn to the type-wheel to receive an impression.

Professor Hughes has also invented a very ingenious printing-telegraph, depending upon the synchronous revolutions of two or more type-wheels at different stations. See PRINTING-TELEGRAPH.

Various forms of dials or pointer telegraphs have been devised by Breguet in France, Siemens and Halske and Kramer in Germany, and various improvements in the details of construction by numerous others which the limits of this article will not permit us even to refer to. See specific index under TELEGRAPH.

E-lec'tro-mag-net'ic Watch-clock. An apparatus consisting of a magnet, with a recording-dial, clock-works, and a signal-bell; from this run wires, one to each of the banks or other offices under guard where watchmen are employed, whose duty it is to visit each bank at stated times during the night and give signals, which are recorded on the dial of the clock in the fire-alarm office, showing the time that the signal was given from any particular bank or office.

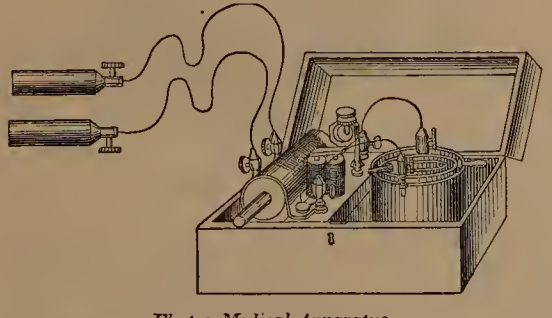
If the signal is not given within five minutes after the appointed time, the man on duty at the fire-alarm office communicates with the office of the superintendent of police, and an officer is immediately despatched to the point from whence no signal has been sent.

E-lec'tro-med'i-cal Ap'pa-ra'tus. An instrument for the treatment of diseases by electro-magnetism.

Great success in this line was announced by Johannes Francisco Pavate, at Venice, in 1747. The details of the apparatus employed by him are not known.

From that time to the present the treatment of diseases by electrical appliances has undergone its

Fig. 1851.



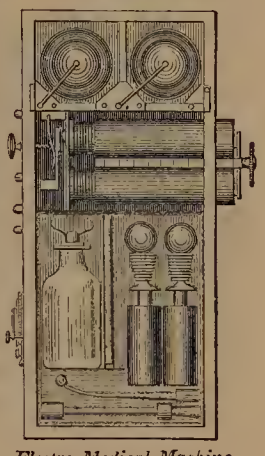
Electro-Medical Apparatus.

vicissitudes in public favor, becoming notably prominent after the discovery of voltaic electricity and of the properties of electro-magnetism. The latter is now generally adopted.

Fig. 1851 shows a machine designed for medical purposes. It is operated by a single-cell Daniells battery, the current from which, after passing through a helix, is conducted by wires provided with insulating handles to any part of the person to which it is desired to apply the treatment.

In the instrument shown in Fig. 1852 two small coils, connected with each other and furnished with a vibrating contact-breaker, are traversed by the currents from a small battery. The coils are surrounded by hollow cylinders of copper or brass in which induced currents are generated. These may be slipped on or off the coils, to intensify or moderate the strength of the current, which is directed by appropriate wires to the parts under treatment.

Fig. 1852.



Electro-Medical Machine.

E-lec-trom'e-ter. An instrument to measure the amount of an electrical force.

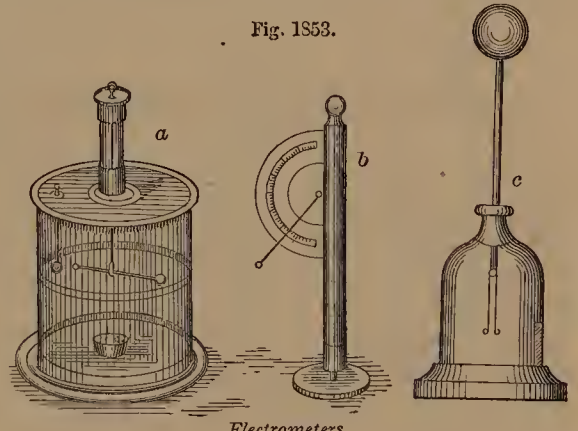
In Coulomb's torsion electrometer (*a*) the force opposed to that of electricity is the resistance to twisting offered by an elastic thread.

In Henly's quadrant electrometer (*b*) the electric force is measured by the amount of repulsion which it produces upon a pith-ball attached to a silk fiber suspended from the center of a graduated arc.

c is the gold-leaf electroscope. See ELECTROSCOPE. Sir William Thomson's and Varley's electrometers are the most delicate of all, and are used in reading the insulating power of telegraph-cables. See GALVANOMETER.

The strength of the electric force excited by the rubbing of glass, sulphur, amber, wax, resin, etc., was measured by Gilbert by means of an iron needle (not very small) moving freely on a point, *versorium electricum;* very similar to the apparatus employed

Fig. 1853.



Electrometers.

by Haüy and Brewster, in trying the electricity excited in different minerals by warmth and friction.

E-lec'tro-mo'tor. An exciter of electric action. An apparatus actuated by electricity and imparting motion to a machine. See ELECTRO-MAGNETIC MACHINE.

E-lec'tro-neg'a-tive. Having the property of being attracted by an electro-positive body, or a tendency to pass to the positive pole in electrolysis.

E-lec'tro-nome. A measurer of electricity. See ELECTROMETER.

E-lec-troph'o-rus. An instrument invented by Volta, for generating electricity by induction, about 1776.

Volta's electrophorus (*A*, Fig. 1854) consisted of a thick disk of resin 12 or 15 inches in diameter, called the *plate*, resting on a tin foil called the *sole*. The plate has a metallic cover, insulated by a glass handle.

The resinous plate being excited by rubbing it with a warm and dry flannel, the metallic cover is placed upon it, and a spark of − electricity may be drawn from it; if it then be raised, it affords a spark of + electricity. On replacing the cover and again

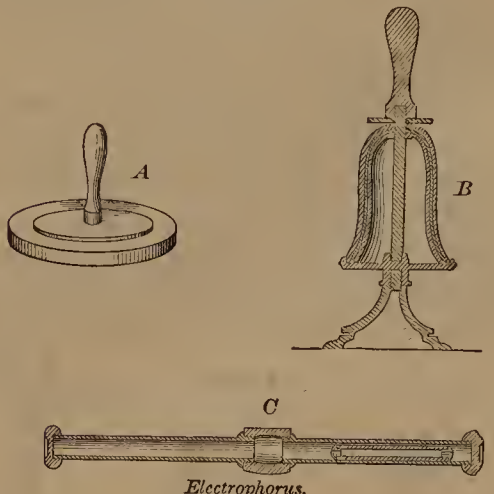
touching it, it affords another spark of – electricity, and so on.

It forms a portable electrifying-machine, and is used as a gas-lighter by developing a spark over the burner, inflaming the issuing gas.

The electrophorus *B* has a metallic bell lined with fur or wool, and a hard-rubber handle. It has also an interior bell of hard rubber with a metallic pedestal and foot. The act of raising the metallic bell generates frictional electricity, and the bell being brought into contact with an insulated chain attached to a burner develops a spark over the latter, thus lighting the gas.

In the electric wand *C*, the electricity is generated by a metallic tube sliding in a fur-lined reservoir of hard rubber, and is applied, as the bell just described, by establishing a circuit except at a short break over which the spark jumps.

Fig. 1854.



Electrophorus.

Another wand carries a Leyden jar.

E-lec'tro-pho-to-mi-cog'ra-phy. The art of photographing objects as magnified by the microscope by the help of the electric light.

E-lec'tro-plat'ing. A means of covering a metal or a metallic surface by exposure in a bath of a solution of a metallic salt, which is decomposed by electrolytic action.

Early in the present century, Volta demonstrated that a solution of a metallic salt, under the influence of the voltaic pile, became immediately reduced to its elements, in such a way that the metal was deposited at the negative pole. This was regarded as an interesting fact, of some moment to electricians, but not of special interest in the arts.

"Some curious experiments have lately been made by Mr. Cruickshank of Woolwich. On passing the galvanic influence by means of two silver wires through a solution of nitrat of silver, the upper wire became oxidated and gradually corroded, while at the same time a beautiful arborescent precipitation of metallic silver took place on the lower wire. Acetite of lead and sulphat of copper were similarly decomposed and precipitated on the lower wire."— *Monthly Magazine*, August, 1800.

In 1801, Wallaston demonstrated that a piece of silver in connection with a more positive metal placed in a bath of sulphate of copper became covered with copper and would stand burnishing.

It was not until 1838 that Mr. Spencer gave it a practical bearing by making casts of coin and casts in intaglio from the matrices thus formed.

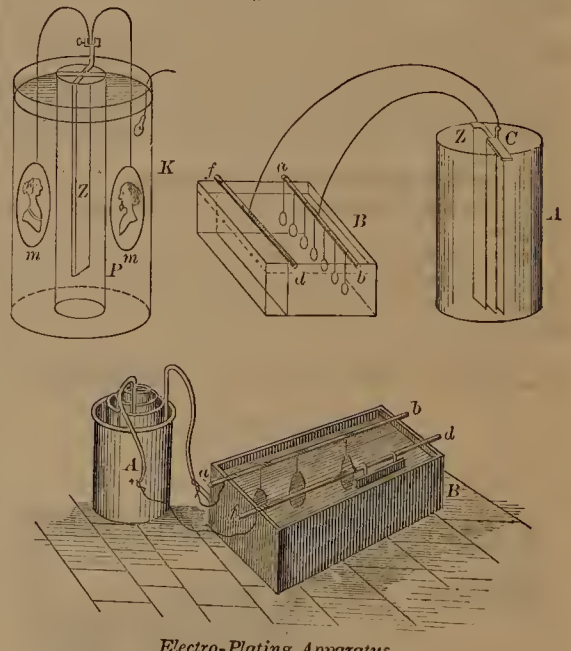
Professor Jacobi of Dorpat, in Russia, had been an independent inventor, and in the same year brought forward specimens which were much admired and caused him to be put in charge of gilding the iron dome of the Cathedral of St. Isaac at St. Petersburg. This dome weighs about 448,000 pounds, and was electro-gilded with 274 pounds of ducat gold.

The process, briefly described, is as follows: —

The voltaic current employed is supplied by a constant battery, such as Daniells's or Bunsen's. In the simple form, the galvanic current is produced in the same vessel in which the metallic deposit is effected. The outer vessel *K* of glass, stone-ware, or wood, contains a solution of the metallic salt, — say sulphate of copper. A smaller vessel *P*, of unglazed porcelain, contains diluted sulphuric acid. A plate of zinc *Z*, forming the positive pole, is suspended in the acid solution and connected with the copper medals *m m* by means of a copper wire. Electrolysis ensues, the copper in the solution is deposited on the medal which forms the negative pole, and the strength of the solution is maintained by suspending a bag of crystals of sulphate of copper in the bath.

In the compound form the galvanic current is produced outside the bath containing the solution to be

Fig. 1855.



Electro-Plating Apparatus.

decomposed. In this arrangement a current of any degree of strength may be employed, according to the size and number of cells forming the battery. *A* is the battery, *B* the vessel into which the solution of the metal to be deposited is placed; the molds are suspended from a metallic rod *a b*, opposite to which the plate *f d* is hung; copper, if the solution is a salt of that metal, will serve as a soluble electrode, and will be dissolved in the same ratio as the metal is deposited upon the mold. The battery being charged, *f d* is put into communication with the copper pole *C* by a copper wire, and *a b* is put in communication with the zinc pole *Z*.

The voltaic current being passed through the solution of a metal, decomposition takes place, the metal being electro-positive attaches itself in a metallic state to the negative pole or to the object attached thereto, — the medal, for instance, — while the oxygen or other electro-negative element seeks the positive pole.

The *anode* is the electrode placed at the positive pole of the battery, which in the electro-chemical decomposition can be dissolved, or which, if it be

insoluble, attracts oxygen and acids. The *cathode* is the electrode which, placed at the positive pole, receives the metallic deposit, or attracts hydrogen and alkalies.

If the article to be coated be a medal or other object which is a conductor of electricity, the deposit will be made directly upon it; but if it be an engraved wooden block, a wax seal, or a plaster-cast, it is necessary to give it a conducting surface, which is done by brushing it over with black lead or bronze powder.

In obtaining the counterpart of a medal or engraved plate, the latter must necessarily be coated with some substance to prevent adhesion of the matrix. In the United States Coast Survey a solution of iodine is employed in the duplication of its copper-plates.

In Shaffner's process, wood, fabric, or fiber is prepared to receive a metallic coating by immersion in a bath containing plumbago in suspension.

Fibrous substances may also be prepared by dipping in a solution of nitrate of silver and ammonia, and exposure to hydrogen gas.

The process of electro-plating has been applied to many substances, as terra-cotta, wood, cloth, lace; and to the ornamentation of book-covers and similar objects; and also for soldering, by uniting the adjacent edges of two pieces of metal by forming a solid mass between them. The works of a chronometer watch have been electro-plated while going.

When applied to depositing a coat of silver or gold upon an article, it is placed in a solution of the required metal, the acid set free in the reaction being such as will act upon the piece of metal whose function it is to keep the metallic solution to its normal strength. Copper and its alloys and German silver are the metals upon which gold or silver are most readily deposited.

Electro-plating with iron has been done in Russia by a process invented by Jacobi and Klein; it is much more durable than copper, and is said to afford good results, having been used by the Russian government for printing bank-notes. A United States patent was granted for this process in 1868. See also Garnier's process, "Photographic Journal," Vol. VI., p. 31 *et seq.*

An important improvement in electro-plating is that of M. Oudry of Auteuil, near Paris, for coating large objects made of iron with a thick layer of copper. In the old process it was customary to clean the pieces to be plated, and after subjecting them to a weak preliminary bath, in order to form a thin film on the surface, to transfer them to a stronger bath, where they were subjected to voltaic action for several days. In this part of the process it was found that, owing to the strength of the acid bath, and the imperfection of the preliminary coating, the iron was corroded, instead of becoming coated with copper.

The details of M. Oudry's process have not been made public, but as a preliminary to the plating the articles are covered with three coats of benzine and afterward rubbed with pulverized charcoal, when they are ready for the bath, which is composed of a saturated solution of sulphate of copper.

The battery used is Daniell's.

The operation requires from three to four days, by which time a deposit about one twenty-fifth of an inch in thickness is formed. The objects, when removed from the bath, are washed in slightly acidulated water, brushed with a wire brush, and rubbed with paper to brighten them, after which they are brushed with ammoniacal acetate of copper, and finally polished with a hard brush well waxed.

By this process many of the cast-iron monuments in the city of Paris have been copper-plated, and also the street lamp-posts. Cast-iron lamp-posts weighing 4½ cwt. plated in this way cost about $40, while those of bronze of similar pattern, though weighing but 2¾ cwt., cost $150.

Herr W. Licke, of Hanover, deprecates the use of the acid bath, and advocates the use of a tartrate with either a soda or a potash salt, especially for coppering iron by means of galvanism. The best results were obtained with a solution of 20 parts of crystallized sulphate of copper in 160 parts of water, which solution is mixed with 50 parts of neutral tartrate of potash dissolved in 650 parts of caustic soda solution of 1.12 specific gravity.

E-lec'tro-po'i-on-bat'ter-y. (*Elektron-poiëo*, Gr., electricity-making.) A name applied specially to Bunsen's carbon battery, though applicable to other forms.

E-lec'tro-pos'i-tive. Having a tendency to the negative pole of a magnet or battery.

E-lec'tro-punct'ur-ing. Treatment by the insertion of needles in the body, and passing a voltaic current between the points.

E-lec'tro-scope. An instrument for detecting electrical excitation. It is shown at *c*, Fig. 1853, and consists of a glass jar with a wooden bottom, a brass wire passing through the cork and surmounted by a ball of the same metal; to the lower end of the wire are gummed two depending strips of gold-leaf. The test of the electric condition of a body is to bring a small ball suspended from a filament of silk against the body, and then apply the same ball to the knob of the electroscope. The presence of electricity will be shown by the divergence of the leaves, which, being similarly electrified, will repulse each other. A rod of glass or of sealing-wax rubbed and applied to the knob will determine whether the previous excitation was positive or negative.

The dry-pile electroscope consisted of a gold-leaf suspended between two balls, and Grove improved on this by insulating the gold-leaf between two surfaces and charging it at the same time by an electrified rod. See ELECTROMETER.

E-lec'tro-tint. A mode of engraving in which the design is drawn on a copper plate with an acid-resisting varnish. By the electro-bath a reverse is obtained, and from this copies are printed. The process may be adapted to relief or to plate printing.

E-lec'tro-type. A copy, usually in copper, of a form of type. An electrotype is superior to a stereotype, as copper is harder and more durable than type-metal, and the plates take less room in storage.

A page of the type is covered with wax, which is driven into the interstices by powerful pressure. The face of the wax-mold is covered with plumbago to give it a metallic surface to which the metal will adhere. The positive pole of a battery is attached to the mold, and the negative to a copper plate, and both are plunged in a bath of sulphate of copper in solution. The copper is deposited on the face of the mold in a thin film, which increases in thickness as the process continues. The *shell* having attained the thickness of a stout sheet of paper, the mold is removed from the bath, the shell detached, and strengthened by a backing of type-metal.

This process is called *backing-up*. As type-metal will not readily adhere to copper, the back of the shell is coated with tin, and the *shell* is then placed face downward on a plate, by which it is suspended over a bath of molten type-metal. When it has attained the requisite heat, a quantity of the metal is dipped up and floated over the back of the shell.

When cold, the plate is reduced to an even thickness by a planing-machine. For printing, it is mounted on a wooden backing.

Another mode of obtaining electrotype plates from a letter-press form is by a mold of gutta-percha, brushed with graphite and immersed in the electro-plating bath.

Gutta-percha is also used for obtaining intaglio molds and then cameo impressions from woodcuts, for printing. See ELECTRO-PLATING.

E-lec'tro-typ'o-graph'ic Ma-chine'. An apparatus invented by Fontaine, a French barrister, for printing short legal documents, etc.

The letters of the alphabet — caps, lower-case, figures, etc. — are arranged around two horizontal disks, one above the other, and surmounted by a third disk which has notches corresponding to the types below. A bar in the center is caused to press upon the notch representing any particular letter, which is, by electro-magnetic action, caused to drop and leave its impression on a sheet of paper wound upon a roller beneath, and then return to its place.

When the whole has been printed, letter by letter, in this way, an impression is transferred to a lithographic stone, from which any number of copies may be printed.

E-lec'trum. 1. Argentiferous gold : an alloy of gold and silver.

A vase and eight drinking-cups of this material were found in an ancient Scythian tomb at Kertch.

2. An alloy of copper, zinc, and nickel : German-silver. See ALLOY.

El'e-phant. A size of drawing-paper measuring 28 × 23 inches, and weighing 72 pounds to the ream.

A flat writing-paper of about the same dimensions.

El'e-vat'ed Bat'ter-y. One which has its whole parapet elevated above the natural surface of the ground ; to procure the mass of earth required, a ditch is usually dug directly in front of the parapet.

El'e-vat'ed Ov'en. One whose baking-chamber is situated above that plate of the stove in which are the holes for the pots and kettles.

El'e-vat'ed Rail'way. A railway with an elevated track.

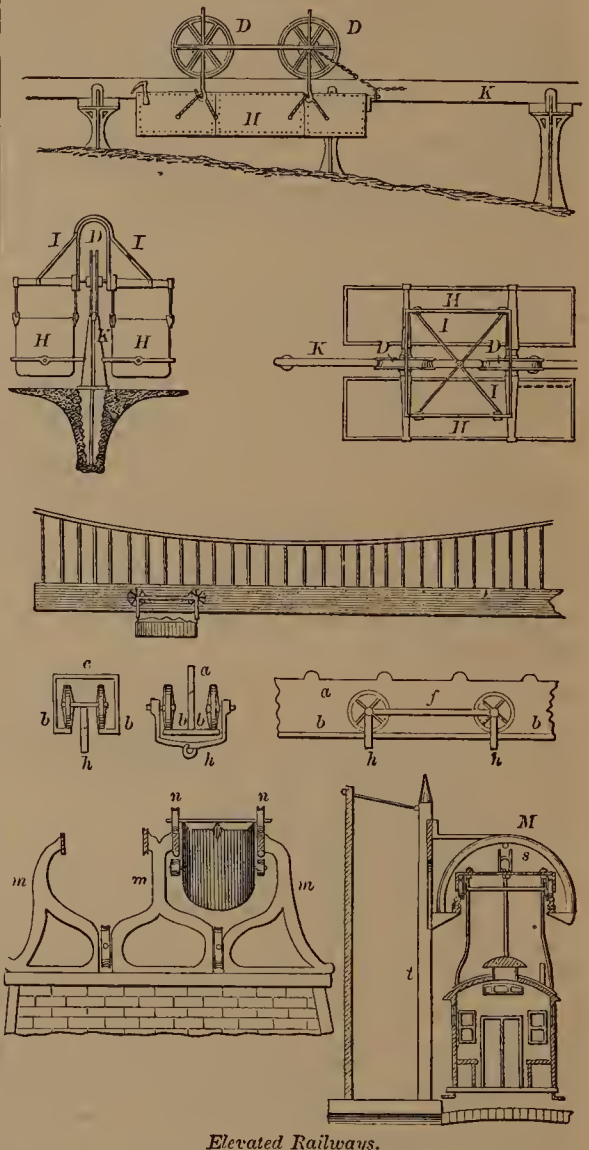
Any railroad supported on a continuous viaduct may be said to be an elevated railway, but the term has lately received a rather more limited application. It is now particularly applied to city railroads whose track is so elevated as not to materially infringe upon the street area, already too limited for the convenience of the citizens and the traffic.

The necessities for more convenient transportation of passengers in New York City, especially on Broadway, have perhaps given the greatest stimulus to invention in this line, and the question of elevated railway *versus* subterranean railway has been very thoroughly debated.

The capitals and other large cities of the world were not originally laid out for the modern means of locomotion. We see in the cities of Asia the condition which formerly existed in European towns, — narrow streets without sidewalks, adapted for pedestrians, equestrians, pack-animals, and sedan-chairs. Jeddo, Macao, and other Asiatic cities where the natives are yet dominant, have in general no provision for wheeled vehicles, and London before the great fire of 1666 was in much the same condition. The foot-traveler was jostled by the horseman, and stood on one side to let the train of pack-animals go by, just as the modern traveler resigns the road in favor of the loaded camel or the ambling donkey in the streets of Alexandria. The sedan-chair of England and the palanquin of Constantinople were carried by shambling porters, who were attended after nightfall by torch-bearers and guards, who illuminated the way and kept off the prowling robber. Asia, having stood still, preserves the institutions to which we have alluded ; Western Europe and the West have outgrown them some time since.

The topography of old Boston and Dutch New York show that no ideas of these modern stirring times troubled the engineers and architects of those days, and it has become a problem with their successors how best to adapt the thing as they find it to modern needs.

Fig. 1856.



Elevated Railways.

London has solved the problem by brick viaducts and subterranean railways, which are successful and safe ; of the latter it may be added, profitable.

New York, of all our American cities, is most interested in obtaining the best solution of the problem.

The viaduct of the London and Greenwich Railway is 3 miles and 60 chains in length ; being composed of over 1,000 yellow brick arches, 18 feet span, 22 feet high, 25 feet wide. It cost over $1,300,000 per mile, and has not proved a paying investment to the shareholders.

The London and Blackwall Railway is upon a

continuous viaduct of brick arches, and is 3 miles 38 chains in length. It cost £1,083,951. The public are benefited more than those who built it.

These are two examples of elevated railways of a certain kind. The Greenwich Railway was always worked by locomotives. The Blackwall Railway was for many years worked by stationary engines and wire ropes.

In 1821, Palmer, engineer to the London Dock Company, patented a railway whose single track was elevated upon pillars, which were of such lengths as to bring the track to a level or moderate inclination, notwithstanding the inequalities in the surface of the ground. This is shown in the upper illustrations of Fig. 1856. The boxes *H* are in pairs, suspended on each side of the carriage, which travels upon a pair of grooved wheels *D*. The track *K* is supported on the pillars. The wheels are placed one before the other, and the axles are extended laterally so as to support the boxes by the suspension-rods *I*. The lower side of the box having a continuous longitudinal slit, allowing the passage of the suspension-bar.

The mode of propulsion is probably by a wire or rope.

Dick's elevated railway (English patent, 1825) had a double track supported on vertical pillars *m m* of varying hight when crossing irregular surfaces, so as to preserve a level, or nearly so.

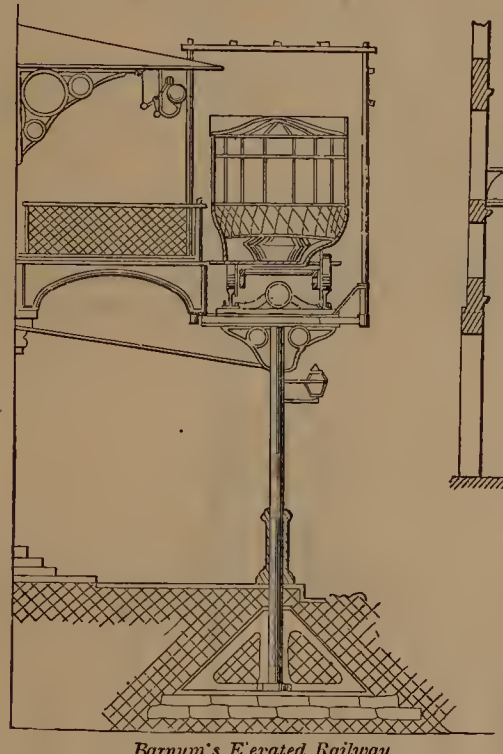
The track has two rails, upon which the wheels *n* of the carriage traverse; and beneath the rails are safety-wheels on the sides of the carriage, which keep the upper wheels from leaving, should the carriage sway and jump with high speeds.

The mode of propulsion was to be by drag-ropes from stationary engines. The lower wheels journaled between the sections of the supporting frame are for the ropes to run in.

Warren and Blume's elevated railway *M* is on the principle of the Fisher (English) patent of 1825.

The rails are supported upon inward projections at the spring of an arch *s*, which is attached by one end to a single post *t*. A truck runs on this track,

Fig. 1857.



Barnum's Elevated Railway.

center of gravity of the loaded boxes is below the level of the rail.

The carriages are hooked together, and are drawn by horses and a towing-rope.

A railway on this principle was constructed in 1825 at Cheshunt, in England, and used for conveying bricks across the marshes to the river Lea, where they were shipped.

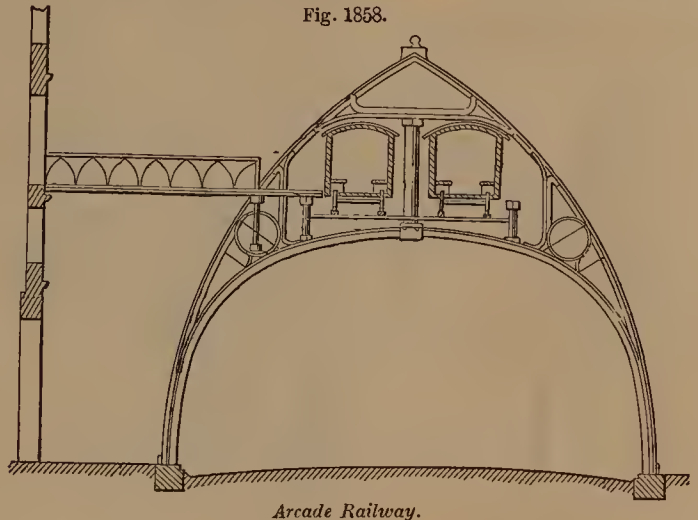
Fisher's English patent, 1825, in the same figure, shows a suspended carriage between two lines of rail.

In the figure, the bar *a* with rail-flanges *b b* is shown suspended by rods from a catenary chain, which is supposed to be spanning a river or deep gulley.

The carriage *f* has two pairs of wheels which traverse upon the flanges *b b*, and support the bar *h* from which is suspended the freight.

One of the views shows a modification, in which the rails are flanges of a hollow box or trunk *c*, the

Fig. 1858.



Arcade Railway.

and the car is suspended from the truck, and is drawn by horses. The truck wheels have brakes which are operated from the car.

Fig. 1857 shows another form which is supported on columns and reached from the second floors of houses. It is driven by dummy-engine, compressed air, or by rope.

Another form is proposed to span the street and form an arcade. (Fig. 1858.)

Cheseborough's elevated railway consists of a series of inclined planes down which a car runs by its own gravity, elevating platforms being interposed to raise the car from the foot of one incline to the head of the next. The platforms are elevated by a perpendicular lift operated by compressed air.

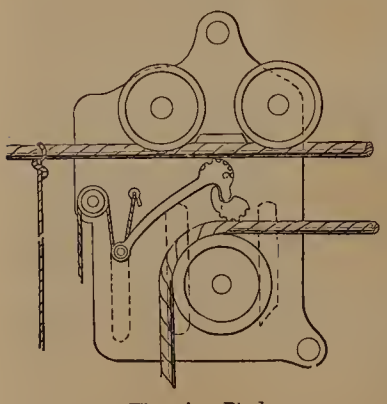
In India, Australia, and some other places, it has not been unusual to cross gullies and rivers by means of a bucket or basket suspended from a cord. The patents of Palmer, Fisher, and Dick, already cited, are an amplification of this idea, a carriage being arranged to travel on a rail.

The idea has recently been reduced to practice in a compact and useful form. See WIRE-WAY.

El'e-vat'ing-block. A tackle-block used in elevating hay or bales, where, after the object has been raised to a given hight, the block is required to travel along to a position above where the load is to be deposited.

The track-rope passes through the case under the

Fig. 1859.

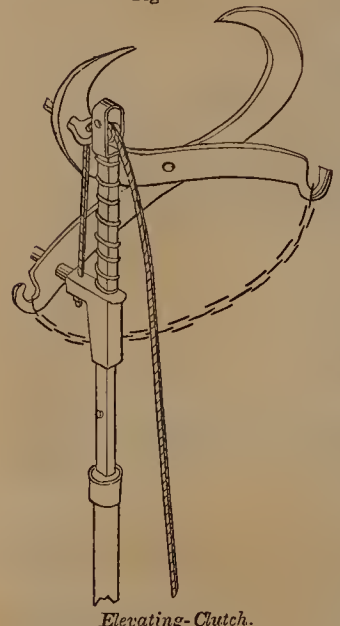


Elevating-Block.

locomotive pulleys. The draft-rope leading from the hay-fork to the team passes between the lower pulley and the stop. The cord running over the pulley in the rear operates the stop that rigidly connecting the draft to the track-rope above arrests its progress in either direction. It is managed by a depending check-rope, which is grasped by a man on the barn or warehouse floor.

El'e-vat'ing-clutch. Designed to attach a clutch to an elevated beam in a barn, as a means of suspension of the tackle of a horse hay-fork, and to detach the clutch therefrom when required. It has two arms attached to a handle of any suitable length, and arranged to engage the jaws of the clutch to hold them open until the beam is grasped or to unclose them when required.

Fig. 1860



Elevating-Clutch.

El'e-vat'ing-screw. One beneath the breech of a piece of ordnance, to give the elevation or vertical direction to the piece. In field-pieces it is bedded in the stock immediately under the base-ring of the gun, which rests on the top of the screw. The latter is turned by four handles.

In theodolites and other geodetical and astronomical instruments a similar contrivance is used for leveling the instrument. See also JACK-SCREW, etc. See list under HOISTING.

El'e-va'tion. 1. (*Astronomical Instruments.*) The arc of a vertical circle intercepted between an object and the horizon.

2. (*Dialing.*) The angle of the gnomon with its base.

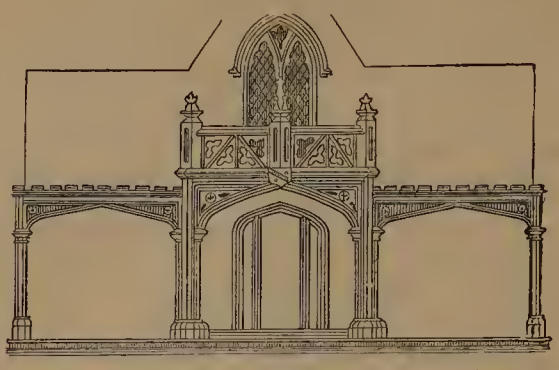
3. (*Gunnery.*) The angle of the line of fire with the plane of the horizon.

4. (*Drawing.*) A side or end view of an object or representation on a perpendicular plane.

An end or side view of a building or machine drawn according to the actual width and hight of its parts without reference to perspective.

Projections or depressions from the plane of the general surface are indicated by shadows equal in width to the depth of the elevation or depression, the light being supposed to fall at an angle of 45° both to the vertical and horizontal lines of the drawing, and usually from the upper and left-hand side.

Fig 1861.



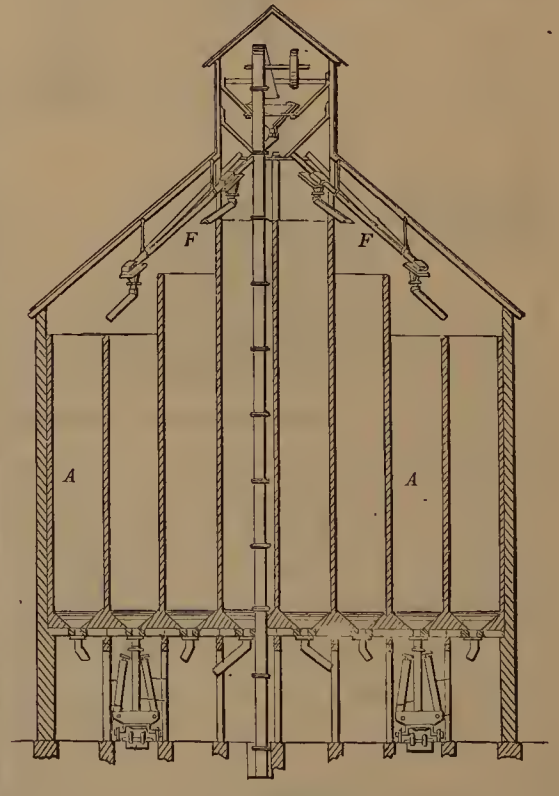
Elevation: — Porch and Veranda (Rural Gothic).

El'e-va'tor. 1. A machine for transferring grain by raising it from the car, a bin, or the hold of a ship, to an elevated hopper, whence it is discharged by any one of a series of spouts directed to a bin for storage or to the hold of a boat, a car, or to a run of stones.

Elevators are used in flour-mills to carry the wheat to the upper story, where it is cleaned in the smut-mill; also to raise wheat, so cleaned, to a bin whence it proceeds to the stones; also to raise the meal to the bolt, the offal to the bran-duster, etc., as the case may be.

Elevators are also used in many other machines for raising small objects or materials, such as the tailings in a thrashing-machine or clover-huller. These may be consulted where they occur under these heads. They are also used in elevating bricks, mortar, etc., in building. See list under HOISTING-MACHINES.

Fig. 1862.



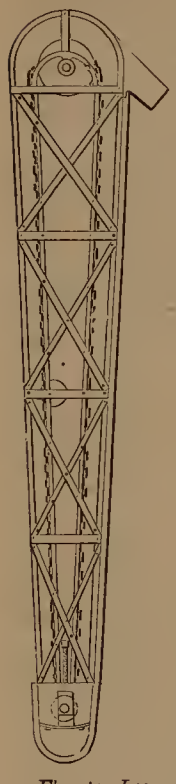
Grain-Elevator

2. A platform or cage in a warehouse, hotel, mine,

or elsewhere, for raising or lowering persons, goods, or material to or from different floors or levels. See HOIST; MAN-ENGINE; CAGE. Also the list above cited.

3. A building specially constructed for elevating, storing, and loading grain into cars or vessels. These structures are very capacious both as to the capacity for handling and storing, but the construction is very simple. An *elevator-leg*, so called, seen in Fig. 1863 and also in Fig. 1862, reaches into the bin or cellar into which the contents of the wagons or cars are discharged. A strong belt, carrying a series of buckets, travels over a drum at the lower end and also over one at the upper end, where the buckets tip over and discharge into the upper bin. This, as seen in Fig. 1862, has valved spouts *F* which direct the contents into either one of the deep bins *A*. The floors of these bins are over the tracks, and valves in the floor allow the contents of the bins to be discharged into cars or canal-boats, which are brought beneath.

Fig. 1863.



Elevator-Leg.

In unloading from ships, the leg is a pivoted, adjustable piece, which is first raised to obtain the necessary hight, brought over the hatchway, and lowered thereinto.

In practice, the grain is discharged into the hopper of a weighing-machine gaged exactly for one hundred bushels; by pulling on a valve the contents are sent by a spout to the bin, the valve closed, the elevating resumed, and so on. Seven thousand bushels an hour are thus weighed. An elevator at Milwaukee is 280 feet long and 80 feet wide. The total length of the great driving-belt, urged by a 200-horse-power engine, is 280 feet, that is, the half extending from cellar to comb is 140 feet, and the down half is of course equal to it. This belt is 36 inches wide and $\frac{3}{4}$ of an inch thick, and is made of six-ply or thicknesses of canvas, with sheets of india-rubber passed between and into them. It drives nine receiving elevators or belts set with buckets, each of which lifts the grain 140 feet. The buckets are made of thick tin, bound with hoop-iron, and are well riveted to the belt at intervals of fourteen inches; six inches across the mouth and eighteen inches long. When full, one contains a peck. They do not usually go up quite full, but, allowing for this, there are 100 pecks = 25 bushels, loaded on one side of one of these belts whenever it is at work. If all nine are running at once, as is often the case, the quantity of wheat lifted on these swift-running belts is 225 bushels. The established weight of a bushel of No. 2 Milwaukee Spring is 55 pounds. This would make the total lift of the receiving elevators during the time they are at work over 12,000 pounds.

The bins in which this wheat is poured are of great size, being 60 feet deep, 20 wide, and 10 across, containing 12,000 cubic feet. The total receiving and storing capacity of this building is 1,500,000 bushels. Of the crop of 1869 it received 7,000,000 bushels. About 10,000 bushels are taken into a train of the average length; so 2,100 trains were that year rolled into this elevator and discharged.

In discharging on to the Lake grain-vessels, as soon as a ship is anchored beside an elevator the hatches are removed and great spouts extend over them from the bottom of one of the bins described. The gate is raised, and a torrent of wheat pours down. The loading power of these spouts is 12,000 bushels an hour. A vessel with a capacity for 18,000 bushels may be loaded in an hour and a half. The Oswego and Ogdensburg schooners and vessels destined for the Welland Canal usually take on from 12,000 to 20,000 bushels. The Buffalo vessels are larger, often receiving 30,000, and in a few cases 45,000 bushels.

4. (*Surgical.*) An instrument employed in raising portions of bone which have been depressed, or for raising and detaching the portion of bone separated by the crown of the trepan. The common elevator is a mere lever, the end of which is somewhat bent and rough, in order that it may less readily slip away from the portion of bone to be raised. The elevator of Louis has a screw peg united to the bridge by a kind of pivot. Pettit's elevator is a straight lever, except at the very point, where it is slightly curved. The triploid elevator consists of three branches united in one common trunk.

The elevator is one of the instruments of the trephine case. A curved instrument for operating upon depressed portions of the skull was disinterred at Pompeii, 1819, by Dr. Cavenke of St. Petersburg.

El'e-va'tor-buck'et. One of the grain-cups on the traveling belt of the elevator.

El'io-type. (*Photography.*) A mode of multiplying photographic copies of artists' work, patented by Eliot, England. The painting is made upon glass in a body-color more or less dense, and consequently more or less effective as a negative, and from it positives are printed.

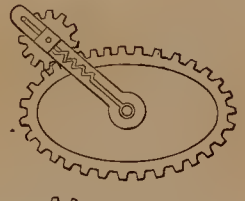
El'i-qua'tion. The process of separating metals by exposure in a furnace or on a hearth to a heat which melts one and does not melt the other. See LIQUATION-FURNACE.

El-lip'so-graph. An instrument for describing

Fig. 1864.

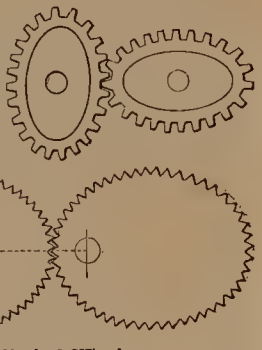
Ellipsograph.

Fig. 1865.



ellipses. The pins of the beam traverse in the slots of the trammel, each occupying its own slot, and the pencil at the end, as the beam revolves, is guided in an elliptical path. See TRAMMEL.

There are many varieties of compass for this purpose.



Elliptical Wheels.

El-lip'ti-cal-arch. (*Architecture.*) An arch having two foci and an elliptical contour. The arches of London Bridge are the finest elliptical arches in the world; the middle one has 152 feet span.

El-lip'ti-cal-gear'ing. See ELLIPTICAL-WHEEL.

El-lip'ti-cal-wheel. One used where a rotary

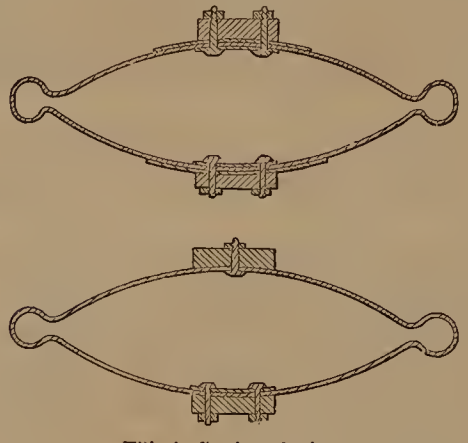
motion of varying speed is required, and the variation of speed is determined by the relation between the lengths of the major and minor axes of the ellipses.

In the upper figure, variable rotary motion is produced by uniform rotary motion. The small spur pinion works in a slot cut in the bar, which turns loosely upon the shaft of the elliptical gear. The pinion is kept to its engagement by a spring on the shaft. The slot in the bar allows for the variation of length of radius of the elliptical gear.

El-lip'tic-chuck. A chuck invented by Abraham Sharp, for oval or elliptic turning. See CHUCK.

El-lip'tic-spring. (*Vehicles.*) One formed of a number of bent plates in two sets, curved apart in the middle and united at the ends. The pressure is brought upon the middle and tends to collapse them.

Fig. 1863.



Elliptic Carriage-Spring.

In the illustrations, the spring is of one or two pieces, united by blocks or bolts.

E-lu'tri-a'tion. Purification by washing, when the water carries off a lighter or more soluble material from the heavier portion, which is designed to be saved. It differs from *lixiviation* in the latter respect.

To recover saccharine matter from animal charcoal, the latter may be *lixiviated*, water being passed through the mass to carry off the sugar.

To remove saccharine and coloring matters from starch in the process of manufacture, the material is *elutriated*, and the granules of starch settle in the bottom of the vat; the substances remaining in solution are removed by decantation.

El-y-dor'ic Paint'ing. A mode of painting invented by Vincent, of Montpelier, intended to combine the fresh appearance of water colors and the mellowness of oil-painting. The vehicle for the pigments is an emulsion of oil and water with the intervention of a gum or mucilage.

Em. (*Printing.*) The square of the body of a type. As the "m" in early fonts had a square body, it became a unit of measure for compositors' work.

E-mail'-om'brant. A process which consists in flooding colored but transparent glasses over designs stamped in the body of earthenware or porcelain. A plane surface is thus produced, in which the cavities of the stamped design appear as shadows of various depths, the parts in highest relief coming nearest to the surface of the glass, and thus having the effect of the lights of the picture. Introduced by the Baron A. de Tremblay, of Melun.

Em-balm'ing. The art of preserving the dead bodies of men or animals. The earliest examples are found in Egypt, where it was practiced over 3000 years ago. There the custom was universal and intimately connected with their religion, as they believed in the resurrection of the body, and imagined that after the lapse of 3000 years the spirit would again inhabit its original tenement if the latter was still in existence. The invention was ascribed by them to Anubis the son of Osiris, who was said to have performed the office for his father.

It has been estimated that more than 420,000,000 mummies were embalmed between his time and the year 700 A. D., when the practice fell into disuse, besides an innumerable multitude of sacred animals, as dogs, cats, apes, ibises, bulls, rams, foxes, crocodiles, serpents, etc., which are found along with human mummies in the tombs.

The Egyptians, however, were not the only people who embalmed their dead. The practice prevailed, though not so extensively, among the nations of Asia, and was, at a somewhat later period, in use to some extent among the Greeks and Romans.

Herodotus gives a long description of the different methods employed by the ancient Egyptians. These varied according to the rank or wealth of the subject.

Drying the bodies in sand was a method chiefly practiced among the poorer classes; and it may be remarked that, in a warm dry climate like that of Egypt, decomposition does not take place so readily or speedily as in those which are favored with more moisture.

Embalming was also performed by salting in natron and then drying; boiling in resins and bitumen; and by removing the brain and viscera, washing with palm wine, and then applying fine resins, myrrh, cassia, and other aromatic substances.

In some cases oil of cedar was injected into the cavity of the body, which was then steeped in a solution of natron for 70 days, when the viscera came away, leaving little but skin and bone remaining.

Among the upper classes, the bodies, after being prepared, were swathed in linen bandages saturated with gum, the total length of which amounted in some instances to more than 1,000 yards.

The physicians embalmed Israel (Gen. l. 2) B. C. 1689, and the bodies of the Hebrew kings were embalmed with spices.

Within and about the bodies of different mummies have been found sulphate of soda, saltpeter, common salt, soda, oil of cedar, turpentine, asphalt, myrrh, cinnamon, and other substances.

The opinion has been advanced that an essential part of the process was the application of heat to the bodies, which were filled with some bituminous substance, by which means creosote was generated. As all mummy bandages were smeared with gum, and bear the appearance of having been heated, being often reduced to tinder, the production of creosote may have been the object for which they were gummed and partially calcined.

The cost of the most expensive method of embalming was a talent of silver, more than $1,100; according to Calmet, the prices ranged from the neighborhood of $300 to $1,500.

The principal materials used by the ancients (the Egyptians excepted) in embalming were honey, brine, wax, and vinegar.

Pharnaces put the body of his father, Mithridates, in brine, in order to preserve it during its transportation to Pompey. Several curious monsters and an ape were pickled and sent to Rome; Pliny and St. Jerome mention them. The body of St. Guibert was pickled to make it keep during a long journey in summer, A. D. 1113.

The bodies of several Grecian kings were preserved in honey. Agesipolis, who died in Macedonia, was thus sent home to Sparta. Alexander is said to have been sent to Egypt in honey; by others, to have been embalmed in Egyptian style. Perhaps he went to Alexandria in honey, and was then embalmed in regular order. The Emperor Julian II. was placed in honey mixed with spices.

Wax and waxen cerecloth were used for centuries in England. The body of one of the Edwards, interred 1307 and exhumed 1774, was preserved in natural shape, but fragile.

The body of Lord Nelson was sent to England in a puncheon of rum. The sailors ran foul of the cask, and, getting drunk, playfully called it "tapping the admiral." The poor man was nearly dry by the time he reached home.

The Scythians, Assyrians, and Persians used wax. The body of Agesilaus was covered with wax, but the practice soon became general of wrapping in waxed cloths. We read of these cerements in the preparation for burial of Philip of Burgundy, 1404; Edward I. of England, 1307; and George II. The cerecloth and aromatics for the latter cost £152.

John Hunter (died 1793) embalmed several bodies by injection into the arteries and veins. The bodies are preserved in the Museum of the College of Surgeons, London.

The Khasias, a people of the Himalayas, preserve the bodies of their dead in honey till the cessation of the periodical rains permits their being burned. The quantity of rain which falls in that region is remarkable. See RAIN-GAGE.

Embalming was practiced by the Guanches, or aboriginal inhabitants of the Canary Islands, and by the ancient Peruvians. Mummies from the latter source are now to be seen in the museum of the Smithsonian Institution. Some bodies have been preserved for ages by burial in caverns, the earthen floors of which contained a notable quantity of saltpeter. The steepes of Tartary, some of the uplands of Montana and Colorado, and the dry uplands of the Andes, are nitrous. Many caves are so also, the Mammoth Cave of Kentucky, for instance.

In very recent times, with the increase of chemical knowledge, considerable attention has been devoted to the subject, and various processes and compounds have been devised.

Dr. Chausier employed a solution of corrosive sublimate, with which the corpse, previously disembowelled and cleansed, is saturated; this imparts firmness to the flesh and renders it imputrescent.

Gaural practiced injecting the veins with sulphate of alumina.

Dr. Ure proposes chloride of mercury and wood vinegar to be used in a similar way. M. Falconi found that sulphate of zinc, injected into a body, would preserve it in a flexible condition for some six weeks, after which it began to dry up, though still preserving its natural color. Chloride of zinc and sulphate of soda are also sometimes used.

A more simple form of preparation for injection, well suited for anatomical purposes, consists of glycerine, 14 parts; soft sugar, 2 parts; nitrate of potash, 1 part. It is found that, after saturation for some days in this solution, the parts become comparatively indestructible, and change neither in size nor figure.

Dr. Hutton's (1863) composition is 4 pounds of zinc dissolved in 6 pounds muriatic acid, to which are added 1 gallon alcohol, 2 drams arsenic, and 1 dram corrosive sublimate; the fluid is injected into the arteries in a heated state.

Dr. Morgan's (English, 1864) is 6 pounds common salt, 1½ pounds nitrate potash, 1½ pounds powdered alum, and 2 drams to 1 ounce arseniate of potash. This, in the form of a solution, is injected into the heart. This process embraces some peculiarities in the mode of treatment of the subject and manner of injecting the fluid.

Coffman's (1867). Distilled water, 1 gallon; carbolic acid, 4 ounces; nitrate of potash, 4 ounces; alcohol, 4 ounces.

Brunetti, of Italy (1867), expels the blood from the tissues by injections of pure water and of alcohol, and fatty matters by injections of sulphuric ether, and afterwards injects a solution of tannin into the arteries, veins, or excretory canals, after which the body is dried in a case heated by steam to a temperature of 90° centigrade.

E de la Granja (1867) employs a solution of sulphurous acid and the sulphides of soda, potash, or lime, in water or alcohol, injected into the aorta. The cavities of the body, head, thorax, and abdomen are filled with tannin, gun-cotton, camphor, and resin dissolved in absolute alcohol or ether, and stiffened with cotton and wax.

Em-bank'ment. A structure raised to prevent water from overflowing a level tract of country, or to support a roadway. Technically, in civil engineering, the earth removed to produce a level is excavation, and that which requires to be heaped up for the same purpose is embankment.

A raised mound or bank of earth to form a barrier against the encroachments of the sea. See DIKE.

Or against the overflow of a river. See LEVEE.

Or to carry a railroad, canal, or road across a tract of low ground or across a ravine or gully. See FILLING.

The oldest embankment in England is Roman, that of Romney Marsh. In the time of Cromwell, 425,000 acres of fen and morasses were recovered, 1649–51.

The embankment by which the Nile was turned from its course before the time of Abraham is mentioned under DIKE (which see). Reference is also there made to some of the works of Holland.

The bottom part of the embankment of the Amsterdam and Haarlem Railways through the low country consists of treble ranges of fascines, tied down by longitudinal poles 39 inches apart from center to center and 10 inches diameter, two double stakes at each end of the poles, and two ties in the intermediate distances. The interstices of the fascines and the space between the rows are filled in with sand. The upper part, forming the encasement for the ballast, is made of three rows of treble fascines, well staked, and wattled together.

A core of sand or clay, faced with step fascines, is made up to low-water mark. Upon this a bed of rushes, fastened down by stakes and wattles, is laid; and the upper portion of the bank is faced with fascines of a regular slope of 1 to 1. See also Wiggins's "Embankments of Lands from the Sea" (Weale's series).

Em-bat'tled. (*Fortification.*) Having a parapet with embrasures.

Em-bo'lus. Something inserted in another and moving therein, as a wedge, a piston of a steam-cylinder, the bucket or plunger of a pump.

Em-bossed' Pa'per. Paper having an ornamented surface of raised work; done by stamping or rolling.

Embossed paper or cards may be copied in metal by taking a mold in wax, treating the surface with graphite, and subjecting it to electro-deposition in a bath of solution of sulphate of copper.

Em-bossed' Print'ing. Printing in which the paper is forced into dies, into which the letters have

been cut or punched. The result is raised letters, used for printing for the blind, and various kinds of ornamental work.

Embossed typography is also effected by pressing

Fig. 1867.

Embossing-Type.

the type into the paper, raising the letters or characters on the other side. See PRINTING FOR THE BLIND.

Em-boss'ing. Ornamenting by raised work or figures in relief.

It is applied to many objects.

Stamps or initials are embossed on envelopes, paper, cards, etc.

Ornaments are embossed on book-covers, especially on those of cloth.

Leather is embossed for binding and many ornamental uses, saddles, porte-monnaies, pocket-books, satchels, etc.

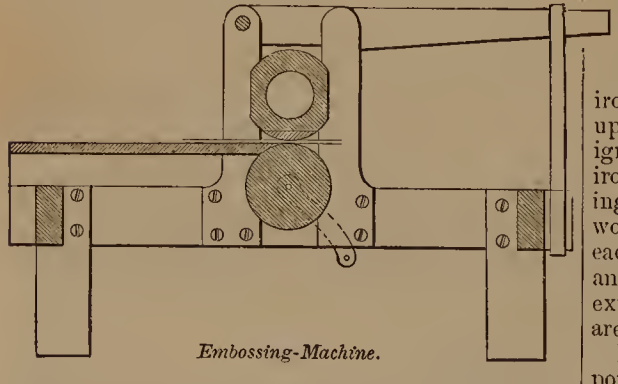
Textile fabrics are embossed for various purposes.

Glass is embossed — so called — by molding with raised figures.

Em-boss'ing-i'ron. (*Sculpture.*) A tool for giving a peculiar grained or caruncular appearance to a marble surface.

Em-boss'ing-ma-chine'. A machine in which a compressible material is placed between a rolling or reciprocating surface and a bed, the moving portion having a design in intaglio, which confers a cameo ornamentation upon the object. In Fig. 1868 the roller has a roughened surface and is rotated by a hand-crank. Above the roller is a hollow press-block having a removable convex-faced plate, with ridges for embossing any substance passed between it and the roller. The block is depressed by a pivoted lever having an elastic press-band over the end.

Fig. 1868.



Embossing-Machine.

The hollow within the block serves to introduce some substance to heat the embossing-plate.

The embossing-machine for giving an indented ornamentation to velvet and other goods (Fig. 1869) has engraved copper rollers, which are heated by inclosed red-hot irons when operating on dampened goods, as in giving a "watered" surface.

Em-boss'ing-press. A hand-stamp or machine for giving a raised surface to an object placed between the descending die and the bed. In the example, the lever is raised by a spring, and is driven down by a blow of the hand, impressing the paper

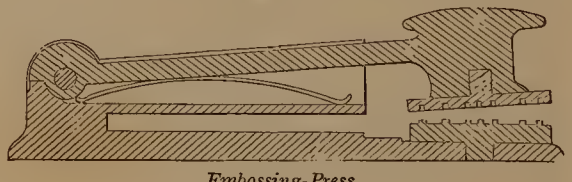
Fig. 1869.

Embossing-Machine.

placed between the intaglio upper die and the cameo counter die.

Embossing-presses of bookbinders are screw, toggle, or lever presses, according to the area of surface and character of material under treatment, and other considerations.

Fig. 1870.



Embossing-Press.

Em-boss'ing Wood. A process of indenting designs in wood by heat and pressure.

The wood is saturated with water, and the cast-iron mold heated to redness and pressed forcibly upon the wood. The water preserves the wood from ignition, though the surface is slightly charred. The iron is reheated, the wood re-wetted, and the branding-iron again applied. This is repeated until the wood fills the mold. The surface is cleansed between each operation, and finally with a scratch-brush, and any desired color may be retained or obtained by the extent to which the charcoal and discolored surface are removed.

Perforated designs are obtained by pressure upon portions of the surface and the removal of a scale of material by a saw. See CARVING.

Em-bra'sure. 1. (*Fortification.*) A crenelle opening cut through a parapet or wall to fire guns through.

The *cheeks* are the sides.

The *mouth* is the widest or outer part.

The *neck* is the narrow part.

The *sole* is the bottom part.

The *sill* is the front of the *sole*.

The *merlon* is the part of the parapet between two *embrasures*.

Embrasures are usually perpendicular to the par-

apet, but are sometimes inclined thereto so as to obtain a line of fire in a particular direction.

2. The inward enlargement of the cheeks or jambs of a window or door.

Em-broid'er-ing-ma-chine'. A form of sewing-machine in which the cloth is moved beneath the reciprocating needle-bar according to the requirements of the tracing, while the needles and hooks retain their respective relative positions above and below the fabric.

Heilmann's embroidery-machine (Mülhausen) has an arrangement by which the needles — 100, more or less — are attached to a carriage which travels to and fro in front of a vertical web. The needles have an eye in the middle and a point at each end. They are grasped by pincers and pulled through.

Em-broid'er-y. Ornamentation by raised figures of needle-work.

This is a very ancient art.

The Egyptians, Babylonians, Medes, and Persians all excelled in it.

The adornments of the tabernacle in the wilderness were of tapestry worked in blue, scarlet, and gold. The garment of Sisera, as referred to by Deborah, was embroidery, "needle-work on both sides." See DAMASK.

Homer refers to embroidery as the occupation of Helen and Andromache.

The tents of wealthy Arabs have an inner covering of white embroidered stuff beneath the dark, outer, water-proof covering of goat's-hair.

"The Tartar women excel in embroidery, and exhibit in this a skill, taste, and variety that is really admirable. It is very doubtful whether it would be possible to find, even in France, embroideries as beautiful and perfect as those sometimes executed by Tartar women." — ABBÉ HUC'S *Travels in Tartary*.

The tent of a late Persian shah was a load for forty camels, and cost $10,000,000. It was embroidered with gold, studded with precious stones and pearls; the figures representing animals, vegetables, and the works of men.

The Chinese, at the present day, are skillful and patient workers at this art, and excel in the disposition of colors.

The North American Indians have a certain rich and barbaric taste in the disposition of colors (preferably scarlet); with the addition of beads, porcupine quills stained, and other mere bizarre ornaments, such as skins, claws, and feathers of birds, claws of bears, ears of the lynx and fox, tails of *Mustelidæ*, shells, etc.

Embroidery is generally done in frames, the woven fabric being stretched flat and the needle passed through and through.

Em'e-rald. A type, used in England, between nonpareil and minion.

Nonpareil.
Emerald.
Minion.

Em'e-ril. A glazier's diamond. A *quarrel*, or *quarry*.

Em'e-ry. An amorphous, compact, opaque variety of corundum, consisting chiefly of indurated alumina. It is extremely hard and cuts almost all minerals, and is extensively used in cutting and polishing glass and other hard substances.

The emery is stamped to powder and sorted into finenesses by bolting through sieves of different degrees of fineness. For delicate purposes, it is sorted by elutriation. It is made up into various forms with gums, resin, glue, clay, etc., according to purpose.

Emery-cakes are used to dress the edges of buffs and glaze-wheels. They are formed of emery melted with bees-wax and made into cakes.

Emery-cloth is prepared by brushing the surface of thin cotton cloth with liquid glue, and sifting the emery-powder over the surface while still warm.

Emery-paper is made in the same way as emery-cloth.

Emery-sticks and rifles are pieces of wood prepared in the same manner.

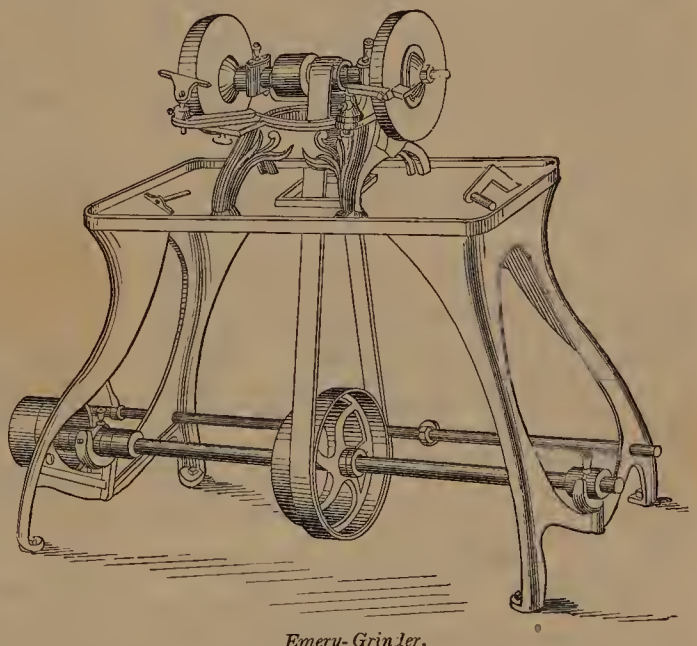
Emery-stones are made or formed of emery of the requisite coarseness, mixed with about half its weight of clay and water, to make a stiff paste, which is forced into a metallic mold by powerful pressure. They are then dried in a muffle. Disks, laps, and wheels are thus made.

Other cementing materials are frequently used instead of loam. See GRINDING MATERIALS; also list under GRINDING AND POLISHING.

Em'e-ry-grind'er. An emery-wheel mounted in a stand, to be used as a grindstone. It may be considered as such, indeed, the mineral corundum with a matrix of gum, resin, glue, vulcanite, etc.

The example is a double machine having two

Fig 1871.



Emery-Grinder.

grinding-wheels and rests; one wheel being at one end and one at the other end of the mandrel, and both outside of the supporting frame. The faces or edges of the wheels may be used.

Em'e-ry-pa'per. Paper brushed with liquid glue and dusted with emery of the required grade of fineness.

Em'e-ry Vul'can-ite-wheel. A compound of emery and caoutchouc, molded into the shape of a grindstone or lap, and vulcanized.

Em'e-ry-wheel. This is a leaden wheel in which emery is imbedded by pressure, or more commonly a wooden wheel covered with leather and with a surface of emery. The wheel is fastened to a mandrel and rotated by a wheel and band; its principal use is in grinding and polishing metallic articles,

especially cutlery. Those wheels in which the edges are used are grinders, buff-wheels, cloth-wheels, glazers, etc. When the flat surface of the disk is used, they are known as *laps*. The wheels may have coarse or fine cutting surfaces for different descriptions of work. For polishing, flour of emery, crocus, or rouge may be substituted. In machine-shops the emery-wheel is known as a *buff-wheel;* among cutlers it is a *glazer*.

Sometimes called a "corundum" wheel, from the specific name of the crystalline alumina used thereon. The hardest known substance next to the diamond. Emery is a dark, granular variety; the sapphire and ruby are peculiarly colored varieties.

E-met'ic-cup. A cup of metallic antimony in which wine is left for ten or twelve hours to become emetic.

Em-is-sa'ri-um. A sluice or flood-gate.

E-mol'li-o-type. (*Photography.*) A collodio-chloride picture on opal glass.

Em-plec'tum. A kind of masonry having a squared stone face; in the Greek it is represented as solid throughout, and in the Roman having a filling of rubble.

One form of Roman *emplectum* has courses of tiles at intervals. See MASONRY.

Em'press-cloth. (*Fabric.*) A lady's dress-goods, all wool and not twilled. It may be considered as an equivalent to the merino, excepting the twill of the latter.

En-am'el. A vitreous, opaque, colored material, tractable in the fire, and used in ornamenting metals; in painting on metals, to be subsequently fired.

Enameled bricks of various colors, blue, red, yellow, white, and black, are abundant in some of the mounds of Babylon and other cities in Mesopotamia. — LAYARD.

Enameled pottery has also been recovered at Thebes. Vestiges of the Roman occupation of Britain are occasionally disinterred in various parts of the country.

The art of painting in enamel or with metalline colors, and fixing them by fire, was practiced by the Egyptians and Etruscans on pottery, and passed from them to the Greeks and Romans. Enameling was also practiced among the Chinese. Specimens of enameled work are yet extant of early British, Saxon, and Norman manufacture. An enameled jewel, made by order of Alfred the Great, A. D. 887, was discovered in Somersetshire, England, and is preserved at Oxford. An enameled gold cup was presented by King John to the corporation of Lynn, Norfolk, and is yet preserved.

Luca della Robbia, born about 1410, applied tin enamel to pottery, and excelled in the art.

Bernard Palissy, the Huguenot potter, born about 1500, devoted many years to the discovery and application of enamels of various colors to pottery. He was remarkably successful in true copies of natural objects. His method died with him. He died in 1589, in prison, for conscience' sake.

John Petitot, of Geneva (1607 – 91), is regarded as one of the first to excel in portraits. He worked for Charles I. of England, and subsequently for Louis XIV. of France. The revocation of the Edict of Nantes drove him from France to the city of his birth, Geneva.

In 1632, Jean Tontin, of Chateaudun, introduced the practice of grinding the colors in oil of spike, instead of water.

Faïence and *majolica* may be considered forms of the art.

The enameled portrait of herself, presented by Queen Victoria to Mr. Peabody, is fresh in the recollection of those who speak the language common to the donor and presentee.

Enamel is applied to various kinds of pots and pans for stewing and preserving fruits whose flavor would be injured by contact with iron, and wholesomeness by being cooked in brass or copper.

The ordinary enamel for the purpose is common glass fused with oxide of lead. This will not resist vinegar and some other acids, and a dangerous poison may be present unsuspected in the mess.

Articles exposed to the weather are sometimes enameled to preserve them from rusting. This has been done with plowshares, mold-boards, water-wheels.

The asphaltum varnish which is burned on to some articles of hardware and household furnishing is not an enamel, but a bituminous varnish. The term *enamel*, as applied to these, is therefore a misnomer.

One of the most familiar examples of enameling is a watch-face. The white ground of these is first fired, the figures being added afterwards.

The backs of gold watches and numerous articles of jewelry are enameled by first engraving them so as to make depressions to hold the pulverized enamel, which is burned in, and the whole polished down to a uniform surface.

Enameled work may be ground by the horizontal lapidary mill or lead-wheel, with emery; second, the same with rottenstone and water; third, polished by the leather lap or buff-wheel with putty powder.

Or the process may be completed in a lathe, using the same materials, and either chucking the object to be ground and polished, or placing it on a mandrel.

In hand polishing, the work is roughed down with slips of water-of-Ayr stone and water, followed by slips of wood dipped in powder of pumice-stone and crocus successively.

En-am'eled Board. Card-board treated with a surface of white lead and size laid on by a large, flat brush and smoothed by a round badger's-hair brush. A powder of talc (silicate of magnesia) is rubbed upon the dried surface of lead, and the face is then polished by the brush.

En-am'eled Leath'er. A glazed leather for boots, shoes, carriage upholstery, and other purposes.

It is prepared from hides, which are split to the required thickness, well tanned, curried, and passed through two operations; the first to render the leather impermeable to the varnish, and the latter to lay on the varnish.

The hides used are those of kip, calf, ox, or horse. They are rubbed on the grain or flesh side with three coatings of boiled linseed oil mixed with ochre or ground chalk, and dried after each coating. The surface is then pumiced, treated with the same material of a thinner quality in several applications.

Over the surface thus prepared are laid successive layers of boiled linseed oil and of the oil mixed with lamp-black and turpentine spread on with a brush. The surface, which has become black and shining, is then varnished with copal and linseed oil with coloring matters. The following is recommended.

Boiled linseed oil	20 pounds.
Turpentine	20 "
Thick copal varnish	10 "
Asphaltum, or Prussian blue, or Ivory black	1 pound.

Five coats of varnish are successively applied, and the colors are varied at will.

En-am'eled Pho'to-graph. (*Photography.*) Metal or pottery is used for the ground; the image is developed by nitrate of silver until the half-tints are overdone or obscured, and the deep shades are covered with a thick deposit. The heat of the muffle drives off the organic matters which formed but vehicles, and the fire cleans the image and restores the brilliancy and delicacy. A thin layer of flux fixes the image. See *Comptes Rendus*, June 11, 1855. "Photographic News," Vol. XIV. p. 86.

En-am'eled Ware. The enameling of hollow-ware is by a mixture of powdered glass, borax, and carbonate of soda, mixed, fused, cooled, and ground. The ware is cleansed with acid, wetted with gum-water, the powder dusted on, and then fused by heat carefully applied.

En-am'el-ing. The art of applying vitrifiable colors to metal, pottery, or glass.

The colors are prepared from the oxides of different metals, melted with a vitreous flux and laid on with a fine brush; the medium being oil of spike or some other essential oil. The work is heated in a muffle, which fuses the colors so that they adhere to the metal or other object.

The principal colors are oxides of lead, platinum, chronium, uranium. Oxides of tin and antimony give opacity.

The enameller works, not with actual colors, but with materials which will assume certain colors under the action of fire. See ENAMEL.

En-am'el-ing-fur'nace. For vitrifying the enamel coating on a plate, glass, or biscuit.

The work is placed in a *muffle*, which consists of an arched chamber in the midst of a small furnace, and surrounded by fuel, which keeps it at a red heat, although the fuel cannot touch the work.

The furnace and muffle are sometimes made of sheet-iron mounted on legs so as to bring the work to the level of the artist's eye.

En-am'el-ing-lamp. (*Glass.*) A glass-blower's lamp with blow-pipe for performing some of the more delicate surface ornamentation of glass.

En-am'el-kiln. (*Porcelain.*) The enamel-kiln for firing porcelain which has been *bat-printed*, that is, *printed on the glaze*, is made of fired-clay slabs, and is 6½ by 3½ feet, and 7½ feet high, with flues beneath and around. The fireplaces are at the sides, and smoke and flame are excluded from the interior.

En-am'el-paint'ing. Vitrifiable colors are laid on metal and fused to it. See ENAMEL.

En-am'el-pa'per. Paper with a glazed metallic coating.

Various metallic pigments are employed, such as will spread smoothly and take a polish. The pigments are white lead, oxide of zinc, sulphate of barytes, china, clay, whiting, chalk, in a menstruum or upon a previous coating of glycerine, size, collodion, water, varnish, etc.; afterwards polished by an agate or between calendering or burnishing cylinders.

En-caus'tic. A mode of painting in which the colors are laid on or fixed by heat.

The ancient Greek encaustics were executed in wax-colors, which were burned in by a hot iron, and covered with a wax or encaustic varnish. Pictures in this style were common in Greece and Rome. (See Smith's "Dictionary of Greek and Roman Antiquities.") The credit to Gausias, of Sicyon, 33 B. C., as the inventor, is rather to be taken as an indication that he was an improver.

Sir Joshua Reynolds, in his attempts to fix his colors durably, mixed wax with them as a vehicle. On one occasion he placed his painting before a fire to mellow the tints by warming the wax. On returning, he found the lady's face had slipped down over her bosom.

The term "encaustic" at the present day is mostly confined to colors burnt in on vitreous or ceramic ware.

By the ancient method, according to Pliny, the colors were made up into crayons with wax, and, the subject being traced on the ground with a metallic point, the colors were melted on the picture as they were used. A coating of melted wax was then evenly spread over all, and, when it was quite cold, was polished.

The art was revived by Count Caylus in 1753. The wood or canvas is coated with wax, which is warmed at the fire. The colors are mixed with white wax and powdered mastic, which are rubbed smooth with gum-water and applied with a brush. The surface is coated with white wax and polished.

En-caus'tic-brick. Diodorus Siculus relates that the bricks of the walls of Babylon, erected under the orders of Semiramis, "had all sorts of living creatures portrayed in various colors upon the bricks before they were burnt."

En-caus'tic-tile. An ornamental tile having several colors. A mold is prepared which has a raised device on its face so as to leave an impression in the face of the tile cast therein. This intaglio recess is then filled by a trowel with clay compounds, in the liquid or *slip* state, and which retain or acquire the required colors in baking. The tile is then scraped, smoothed, baked, and glazed. This tile is common in ancient and modern structures. The glazing came from the Arabs, who derived it from India, and primarily from China.

En-ceinte'. (*Fortification.*) The line of circumvallation; the space inclosed within the ramparts of a fortification.

En-chased'-work. Chased work in silver and gold smithing. See CHASING.

En-chas'ing. A form of engraving which results in an ornamental embossing. It is partly executed by punching on the back and partly by the graver.

Another mode is by filling the object with pitch or lead, and then indenting from the outside.

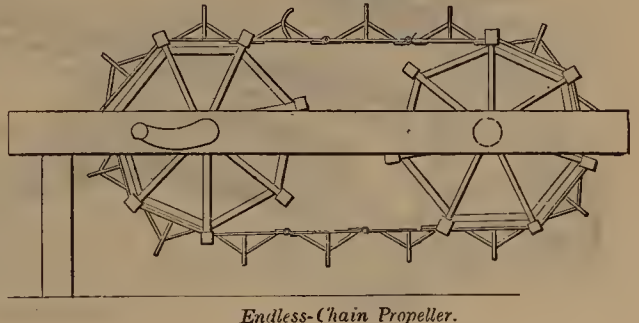
The modes are variously combined, according to the object, the style, and the material. See CHASING.

End. 1. A sliver or carding.

2. (*Weaving.*) One of the worsted yarns in a loom for weaving Brussels carpet. It proceeds from a bobbin on the frame and through a small brass eye called a *mail*, by which it is lifted when its turn comes to be raised to form a loop in the pattern. See BRUSSELS CARPET.

End'less-chain Pro-pel'ler. One in which the paddles are attached to a traversing belt or sets of chains, which rolls over two parallel wheels.

Fig 1872.



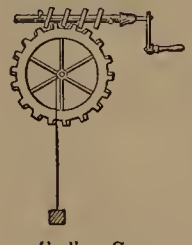
Endless-Chain Propeller.

End'less-saw. A *band-saw*, consisting of a steel ribbon serrated on one edge and passing continuously over wheels above and below the work-table. Used for scroll-sawing, etc. See BAND-SAW.

End'less-screw. A screw whose action is continuous, engaging the teeth of a wheel which is revolved thereby. It is used in graduating-machines, registers, odometers, and in many other places where a means of slow and positive rotation to a wheel is required. A *worm-wheel*.

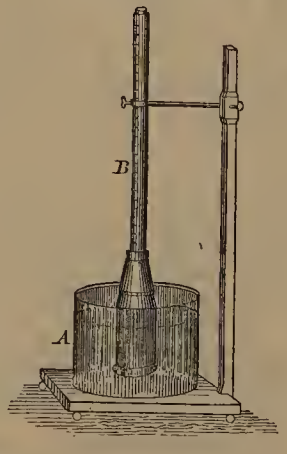
There is a necessary relation between the pitch of the worms on the shaft and of the teeth on the wheel, and a revolution of the shaft moves the wheel a distance of one tooth. By an index arrangement on the shaft to enable it to be turned a certain portion of a revolution, say through 6°, and having, say, sixty teeth in the wheel, the latter may be turned $\frac{1}{3600}$ of a revolution at a time, a distance inappreciable to the eye. This is the *micrometer-screw*. See MICROMETER.

Fig. 1873.



Endless-Screw.

Fig. 1874.



Endosmometer.

En-dos-mom'e-ter. An instrument invented by M. Dutrochet to measure the rapidity of endosmotic action; that is, the passage of a less dense fluid through a membrane which separates it from a denser fluid. The *exosmose*, or passage of the denser fluid in the opposite direction, is slower.

A simple form of the instrument is a trumpet-shaped tube with a membrane covering its bell mouth. The tube is filled with a solution of a given density and plunged in a solution of lesser or greater density to ascertain by successive trials the relative rapidity of the endosmotic or exosmotic actions, or the action of different fluids.

End-shake. A certain freedom of endwise motion of a spindle or arbor, which has bearings at each end, so that the shoulders of the gudgeons or pivots (as in a watch) shall not bear against the journal-boxes or plates.

End-stone. One of the plates of a watch-jewel against which the pivot abuts. See JEWEL.

En'e-ma-chair. One specially constructed for the administration of clysters to the helpless and infirm.

En'e-ma-syr'inge. A syringe for injection *per ano*. See INJECTION-SYRINGE.

En-er'gi-o-type. (*Photography.*) Mr. Hunt's process, called so by him from a supposed influence which he called *energia*, as distinct from light (visible).

En'field Ri'fle. The British infantry service-arm prior to the introduction of the breech-loading system. It was first extensively introduced in 1853, just prior to the Crimean War. It has three shallow grooves, which make one turn in 6 feet 6 inches, the length of the barrel being 3 feet 3 inches, and the diameter of the bore .577 of an inch. In construction and general appearance it very closely resembles the Springfield rifle musket (caliber .58 of an inch) of the United States service, with the exception that in the Enfield the barrel and other visible metallic parts are blued, while in the latter they are left bright. Large numbers of these rifles have of late years been converted into breech-loaders on the Snider principle. To these the term "Snider Enfield" is applied. See FIRE-ARM.

En'fil-ade. (*Fortification.*) The act of obtaining a fire on a work in the direction of one of its faces.

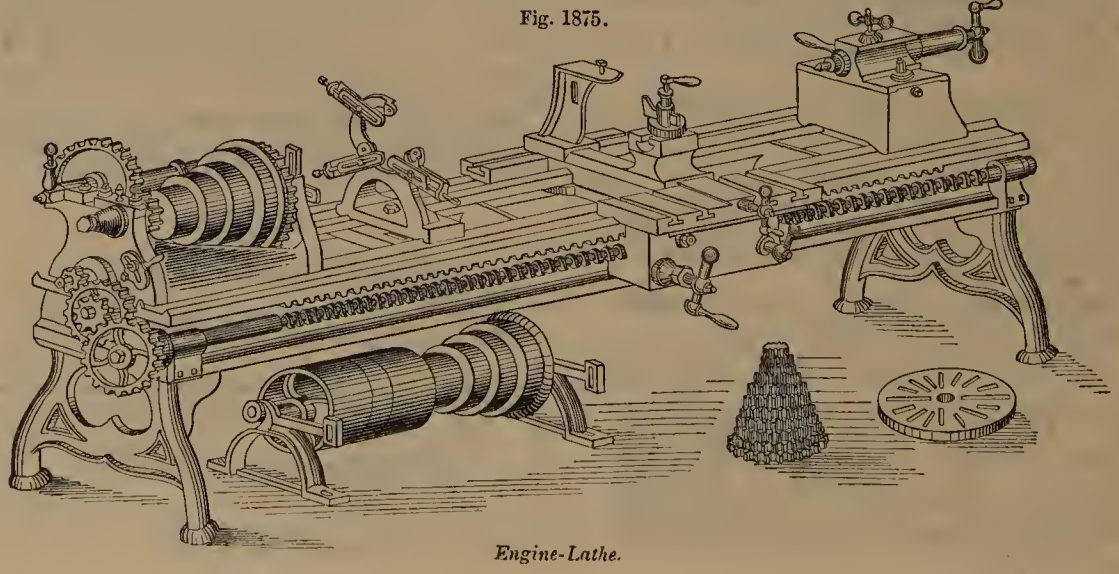
En'gine. A machine which acts automatically, both as to power and operation.

Distinct from a *machine* in its ordinary acceptation, whose motor is distinct from the operator, and a *tool*, which is propelled and operated by one person.

En'gine-fur'nace. A furnace appertaining to a steam-engine boiler.

En'gine-lathe. A lathe of the larger kind, having a capacity for all the principal turning work of a machine-shop. That shown in Fig. 1875 has screw gearing, center and follow rests, and face-plates. On the floor are shown the overhead counter-shaft and cone-pulley, a pile of change-wheels, and a face-plate.

Fig. 1875.



Engine-Lathe.

En'gine-sized. Paper sized by a machine, and not while in the pulp, in a tub.

En'gine-turn'ing. A system of ornamented turning done in a rose-engine lathe, and commonly seen on the outside of watch-cases.

En'gi-scope. A reflecting microscope, invented by Amici, in which the image is viewed at a side aperture in the tube, in a manner similar to the Newtonian telescope.

Eng'lish. (*Printing.*) A size of type between *Great Primer* and *Pica.*

Great Primer, 51 ems to a foot.

English, 64 ems to a foot.

Pica, 71 ems to a foot.

En-grav'ing. Engraving is very ancient. The oldest records are cut in stone, some in relief, some in intaglio. The hieroglyphics of Egypt are cut in the granite monoliths, and on the walls of the tombs and chambers.

In Exodus xxviii. we read that two onyx stones were to be engraved like a signet with the names of the tribes, 1491 B. C. The two kinds of stones of the high-priest's breastplate were engraved with the names of the tribes of Israel. Seals and signet-rings with the cartouches of the Pharaohs are in many museums; those of London, Berlin, Paris, and the New York Historical Society, for instance.

The "graving with an iron pen and lead," referred to by Job (chap. xix.), consisted probably of an etching or scratching process, that of a sharp stylus upon a piece of sheet-lead; Hesiod's poems were thus preserved. The date is not quite determined at which this patriarch of Uz lived; but assuming him to be coëval with Moses, we find quite an advanced state of the art in the time and country of the latter. Moses was learned in all the wisdom of the Egyptians, and when the Israelites went out of Egypt there were a number of skillful workmen able and willing to engrave on precious stones and on metals.

The tools, weapons, and ornaments of the ancient Egyptians are in some cases elaborately engraved. Chasing and carving, which are kindred arts, flourished in the kingdom watered by the Nile.

Layard and his friends disinterred from the mounds of Nimroud, and at other places, many specimens of the graver's art; copper vessels, beautifully engraved, were among the number.

Carving in stone is closely allied to the above, and may be be termed engraving in stone. Egypt is one triumphant vindication of the skill and industry of that nation in this particular. The warlike Osymandyas, nearly 200 years before Abraham, perpetuated upon granite the memory of his exploits, which reached as far as and included Bactria.

The temples, tombs, and obelisks of Egypt, the sculptured palaces of Nineveh, and the gorgeous rilievos of Persepolis, attest the skill and fancy of the artists of the times

"Ere Romulus and Remus."

From Egypt or Phœnicia the Greeks received the art of engraving, where it had considerably advanced in the time of Homer. Among other uses which are allied to chasing and inlaying, it was employed in delineating maps on metallic plates. Specimens of Etrurian art are also of great antiquity, and we prudently do not enter the arena to settle the questions of precedence so lately revived by the wonderful discoveries of General Di Cesnola, in Cyprus.

In the temple of Jupiter Capitolinus were stored 3,000 brass plates on which the laws of Rome were engraved. The ancient engraving was much of it complete enough for printing, but was generally intended for impressions in plastic material, clay, wax, and what not. (See SEAL.) It is, however, believed that parchment, linen, silk, and papyrus were sometimes impressed by the surface of the seal, previously blackened by ink or pigment.

Other than this, the first we know of engraving as a means of delivering an impression in ink or color was among the Chinese. See PRINTING.

The art of engraving is fairly referable to three divisions: *chalcography*, or plate-engraving; *xylography*, or wood-engraving; *lithography*, or stone-engraving: the names being derived from the Greek words *chalcos*, *xylon*, *lithos*, respectively, and the terminal *graphein*, I write.

Engraving on metal originated with chasers and inlayers. This art is very ancient, but does not seem to have suggested the sister art of printing from the plates thus engraved. It appears singular that it did not, for a common mode of examining a piece of engraved work is to fill the engraved lines with a dark liquid, — the dirty oil, for instance, of the polishing rag, — so as to make visible the lines and the effect produced. A piece of soft paper laid on this would obtain an impression, imperfect, it is true, but apparently sufficient to have suggested the art of copperplate printing. In taking a cast in sulphur of some engraved church ornaments, it is stated that a Florentine artist named Finiguerra, about 1440, was led at length to the discovery of the value of plate-engraving as a means of printing. Some dust and charcoal which had gathered in the lines came out upon the sulphur and gave an unexpected and suggestive effect.

Vasari records a similar mode of taking impressions in work, and states that "from these engravings the artists were in the habit of taking impressions by smoking them, and then, after cleaning the surface with oil, impressing upon the work a damp paper." The collections of impressions of these plates in the Florentine and other museums show that, previous to the time of Finiguerra, they are but proofs of inlayer's work, and that they were not made with a view to furnishing prints; the figures have their swords, pens, etc., in their left hands in the impressions, instead of the right.

Had they been engraved for the purpose of printing, the figures would have been reversed on the plate, so as to print right.

Euclid was printed with diagrams on copper in 1482. The copperplate roller-press was invented in 1545. Etching on copper by means of aqua-fortis invented by F. Mazzuoli or Parmegiano, A. D. 1532. Mezzotinto engraving invented by De Siegen, 1643; improved by Prince Rupert, 1648; and by Sir Christopher Wren, 1662.

"Mr. Evelyn showed me most excellent painting in little [miniature]; in distemper, in Indian incke, water-colours: graveing; and, above all, the whole secret of mezzo-tinto, and the manner of it, which is very pretty, and good things done with it."— PEPYS's *Diary*, Nov. 1, 1665.

At Gresham College, the Royal Society meeting, Mr. Hooke explained to Mr. Pepys "the art of drawing pictures by Prince Rupert's rule and machine and another of Dr. Wren's [Sir Christopher]; but he [Dr. Hooke] says nothing do like squares, or, which is best in the world, like a dark room."— PEPYS, Feb. 21, 1666.

These devices are apparently for copying; the

former is probably on the principle of the pantograph; the squares is a familiar mode of reducing or enlarging by ruling off into equal numbers of squares the original and the paper on which it is copied. The *dark room* is probably the *camera-obscura*, in the simple form of a hole in a shutter of a darkened apartment.

"Cocker [the famous arithmetician] says, that the best light for his life to see a very small thing by, contrary to Chaucer's words to the Sun, that he

'Should lend his light to them that small seals grave,'

it should be by an artificial light of a candle, set to advantage as he could do it." — PEPYS's *Diary*, Aug. 8, 1664.

"Come Mr. Cocker, and brought me a globe of glasse, and a frame of oyled paper, as I desired, to show me the manner of his gaining light to grave by, and to lessen the glaringness of it at pleasure, by an oyled paper. This I bought of him, giveing him a crowne for it; and so, well satisfied, he went away." — *Ibid.*, Oct. 5, 1664.

Aquatint engraving invented by St. Non of France, 1662. Engraving in steel introduced into England by Perkins of Philadelphia, 1819.

The earliest application of the wood-engraver's art in Europe was in cutting blocks for playing-cards. The French writers ascribe it to the time of Charles V., but the Germans show cards of the date 1300. The Italians again claim that it originated in Ravenna, about 1285. An Italian pamphlet of the year 1299 speaks of cards as a gambling game, but these may have been drawn by the pen and colored by hand. In the year 1441 the Venetian government forbade the importation of *stamped* playing-cards as being injurious to their handicraft manufacture. Ugo di Carpi introduced the method of printing in colors or tints by separate successive blocks. Engraving on wood assumed the character of an art about 1440; the first impression, 1423. Improved by Durer, 1471–1528; by Bewick, 1789.

Engraving on stone. Work done upon a lithographic stone by etching-point, diamond, or ruling-machine: the stylus of the latter is a diamond.

There are two modes, the first of which is the more usual: 1. The stone is covered with a gum and acid ink-resisting compound, dried, and the design scratched through this ground to such a depth merely as to expose the clean stone. The stone is then oiled, the engraved portions alone absorbing the oil: it is afterwards washed, rolled up, and printed. Printing is, however, usually done from transfers from the engraved stones.

2. The stone is etched through a ground of asphaltum; acid is applied to deepen the lines. These are inked; the face cleaned off, gummed, and etched, the stone rolled up and printed.

Engraving is in many styles, and these are briefly considered under their respective heads, as follows: —

Anaglyphtograph.
Anastatic engraving.
Aquatint.
Autopyrograph.
Banking.
Bite-in.
Bridge.
Burin.
Burnisher.
Cameo.
Celature.
Chalcography.
Chalk-engraving.
Chasing.
Chemitype.
Clamming-machine.
Copperplate engraving.
Counter-proof.
Cradle.
Cycloidal-engine.
Dabber.
Daguerreotype etching.
Diamond-point.
Die.
Dotting.
Draw-point.
Drive.
Dry-point.
Eccentric-engine.
Ectypography.
Electro-engraving.
Electro-etching.
Electro-tint.
Engraving.
Engraving-machine.
Engraving. Photo-
Etching.
Etching-ground.
Etching on glass.
Etching-point.
Finishing.
Galvanograph.
Gem-engraving.
Glass-engraving.
Graver.
Ground.
Grounding-tool.
Intaglio.
Line-engraving.
Lithography.
Lithotint.
Lozenge-graver.
Medallic-engraving.
Mezzotint-engraving.
Niello.
Passe-partout.
Photographic-engraving.
Photograph-plate engraving.
Proof.
Rebiting.
Re-entering.
Relief-line engraving.
Reversing.
Rocker.
Rocking.
Roulette.
Round-point.
Rubber.
Ruling-machine.
Scraper.
Seal-engraving.
Small chisel.
Steel-plate engraving.
Stipple.
Stopping.
Tint-tool.
Transferring.
Transferring-machine.
Wood-engraving.
Xylography.
Zincography.

En-grav'ing-ma-chine'. 1. A machine in which an intaglio impression is delivered upon a plate or cylinder for bank-note printing, or calico-printing, by the rotation under contact with the said object of a hardened steel roller (*mill*) bearing the design in cameo.

This system was invented by Jacob Perkins, and was first adopted in bank-note engraving. (See TRANSFERRING-MACHINE.) The process for obtaining in the design in cameo on the *mill*, by rotation in contact with an intaglio *die*, is effected in a transfer press. See also CLAMMING-MACHINE.

A pantograph is used in etching a reduced copy of a pattern on to the copper cylinder for calico-printing.

Eccentric-engraving, for a certain class of patterns in calico-printing, is performed by a diamond etching-point on the varnished roller. The points are moved by elaborate machinery, and the effect is analogous to that of the *eccentric* and *rose-engine* lathes.

2. An apparatus on the principle of the pantograph, but provided with a cutting device and machinery for causing pressure upon the surface to be engraved, so as to produce lines similar to those made by hand with the graver.

Collas (English patent) engraving-machine, 1830. Electro-magnetic engraving-machine used in Germany, 1854; in America, 1858.

Guerrant and Field's engraving-machine was patented in 1867, and was in operation in New York City during the year 1868. To engrave by means of this machine the operator sits with a copy of the drawing, photograph, or whatever design is to be engraved, directly in front of him. A small pointer rests upon the drawing, and the whole operation consists in moving the pointer over the several lines of the copy. The pointer is operated by two small cranks, one of which produces a vertical and the other a lateral movement; the simultaneous operation of both cranks producing a circular, inclined, or any desired irregular motion of the pointer, which is thus made to "follow copy." All the movements of the pointer are imparted, by means of a simple arrangement of levers, to a graver, which cuts or engraves the design upon the surface of a copper plate or block.

At the Paris Exposition of 1868, an apparatus was exhibited by M. Gaiffe, of Paris, for engraving by electro-magnetism. It consists of two or more disks having their faces in the same vertical and their axes in the same horizontal plane. The graving tools are provided with diamond points, and are connected with the armature of an electro-magnet, and with a tracing-point in contact with the pattern-plate. The tracing-point and graver are caused to approach the centers of their respective plates by a gradual and uniform motion, forming a spiral of extremely close involutions. A design is drawn on the pattern-plate in a non-conducting ink, and as the plates revolve together whenever the tracer crosses one of the lines of the pattern the circuit is broken, and the graver takes the metal of the plate to be engraved; when the tracer, on the contrary, is in immediate contact with the metal of the pattern, the graver is withdrawn from the plate to be engraved.

When the tracer has thus passed over all parts of the pattern-plate from the circumference to the center, a fac-simile of the pattern will have been engraved, in which, however, all the lines of the original will be represented by a series of dots. The pattern may be reduced or enlarged by the application of the pantographic principle; and by the use of a series of gravers arranged on a pivoted bar at various distances from its center of motion, several copies may be made at the same time on scales proportioned to the distance of the gravers from this center.

En-larg'ing-ham'mer. The gold-beater's hammer, by which he reduces the package of *quartiers* or gold-plate. Fifty-six of the *quartiers* form a package (*cauchcr*), and are interleaved with vellum. The hammer weighs fourteen or fifteen pounds, and is shaped like a truncated hexagonal pyramid, 6 inches high. Its face is very slightly convex, and 5 inches diameter.

En-le-vage'-style. A mode of CALICO-PRINTING (which see).

E-nor'tho-trope. A toy on the principle of the *thaumatrope*, the *stroboscope*, and *phenakistoscope*, which depend for their action upon the persistence of visual impressions. Upon different parts of a card are detached parts of a given figure, and when the card is rotated these become assembled and give a combined impression to the eye.

En-rock'ment. Stone pitched on to the seaface of a breakwater or dike, or a shore subject to encroachment by the waves or stream.

En-tab'la-ture. 1. (*Architecture.*) That portion of a classical structure which rests on the columns; it consists of an *architrave*, *frieze*, and *cornice*.

An attic or blocking-course is sometimes added.

Those members of a portico which were constructed upon the columns, consisted of the epistylium, zophorus, and corona.

2. (*Machinery.*) A strong iron frame supporting the paddle-shaft. It usually receives additional stiffness from being confined between two beams of timber, called the *entablature* or *engine-beams*.

En'ta-sis. The swell of the shaft or columns of either of the orders of architecture.

En'ter-ing-chis'el. A spoon-chisel; used by sculptors.

En'ter-ing-file. A narrow, flat file, with considerable taper, to enable it to enter and open a groove, which may be finished by a *cotter*-file, for instance.

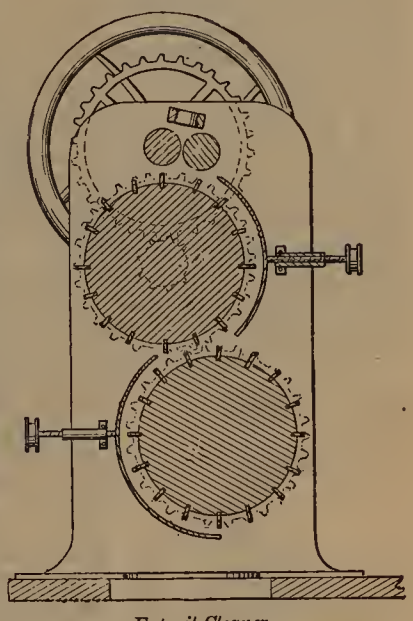
En'ter-ing-port. (*Shipbuilding.*) A port cut in the side of a vessel to serve as a door of entrance.

En-ter'o-tome. An instrument for opening the intestinal canal through its whole extent. It consists of a pair of scissors, one blade of which is made longer than the other, and rounded at its extremity. This is passed into the intestine.

En-to-mom'e-ter. An instrument for measuring the parts of insects.

En'trail-clean'ing Ma-chine'. A machine for cleaning guts for sausage holders or strings.

Fig. 1876.



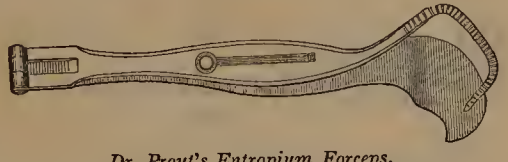
Entrail-Cleaner.

Two rollers, revolving in opposite directions and armed with scraping edges, are surmounted by elastic feed rollers, and provided each with an adjustable curved surface for pressing the entrails against the scraping edges.

En'tre-sol. (*Architecture.*) A low story or part of a story in a building, between two higher ones. *Intersol.*

En-tro'pi-um For'ceps. Forceps for grasping and returning to the natural position the eyelid, in

Fig. 1877.



Dr. Prout's Entropium Forceps.

which, by inversion, the eyelashes have become turned inwardly.

En've-lope. 1. A paper case to contain a folded letter.

2. (*Fortification.*) The exterior line of works surrounding a fort or fortified position.

The besieged are said to be enveloped when completely surrounded by the works of the besiegers.

En've-lope-ma-chine'. The manufacture of envelopes is said to have been introduced by an English stationer named Brewer, some fifty years ago. He cut them from the sheet with the aid of metallic formers, and folded and gummed them by hand with the brush, in the manner generally practiced until a comparatively recent period.

An envelope-machine was invented as far back as 1840, but De la Rue's, 1845, appears to have been the first which achieved any notoriety.

Envelope-machines, so called, generally comprise only provisions for folding and gumming the envelope after it has been cut to the proper form.

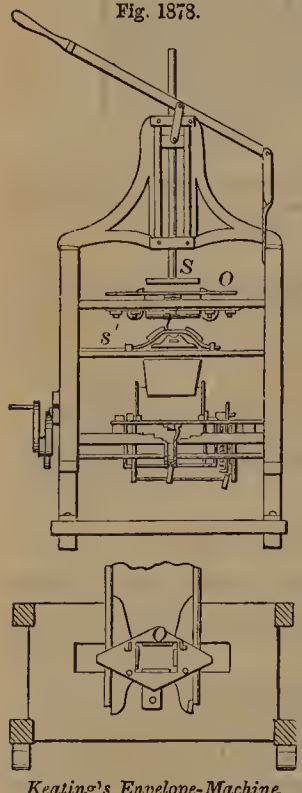
The English envelope-machine, invented by Hill and De la Rue, operates upon diamond-shaped pieces of paper, which are successively placed on the platform. A plunger descends and forces the central

part of the paper into an oblong quadrangular cavity; the four corners stand erect and are successively flattened by four fingers. When the folding is completed, two india-rubber fingers lightly touch the envelope and draw it aside to make room for another. These fingers are small metallic cylinders with tips of india-rubber, which adhere sufficiently to the paper to retract it from its place in the machine and make room for another. The gum is spread over an endless apron or blanket, and an artificial arm takes a supply and applies it to the envelope in its proper place, just before the flap is folded down. As fast as the envelopes are made they are automatically ranged on an inclined plane and slide into a box. The machine (1853) made sixty a minute.

M. Rémond's envelope-machine feeds the blanks by means of a pneumatic apparatus known as an aspirator, consisting of a hollow tube which is thrust forward and rests on the upper blank; the air is exhausted from the tube by an air-pump, and the blank becomes attached thereto by atmospheric pressure. The tube is then withdrawn, removing the blank, which is dropped at the required place, by the relaxation of the atmospheric tension.

The machine of Robineau and Roumestant, exhibited at the Paris Exposition of 1867, also lifts the blanks singly by atmospheric pressure, and folds them and gums them by a series of operations similar to those of Rémond's machine.

Fig. 1878.



Keating's Envelope-Machine.

In another machine, the paper is fed in a continuous strip of a given width for a certain size envelope. First are made transverse incisions, which answer for a portion of the division between the adjacent envelopes; the rectangular crease is made determining the size of the envelope, slits made from the corners of the latter to the edges of the paper; the included flaps are folded over and paste applied; the superfluous edge strip is cut off, and the angular division is made between the adjacent envelopes; the envelope is bent on the folding-line and passed between rollers, to be afterwards dried and have its flap gummed.

In Keating's machine, the paper blanks are placed on a reciprocating feeder-plate *O* and carried forward under the plunger *S* by small hooks or projections. The plunger descends, doubles the blanks by their contact with the creasing-rollers, and leaves the blank on a flat hinged bed, where the flap-folders are actuated to fold consecutively. The auxiliary presser *s'* operates upon the gummed portion, starting directly after the gum-flap folder, which is cut away to allow its passage, and rises a little in advance of it. The counting apparatus is a ratchet and pawl arrangement.

E-o'li-an. 1. A frame with catgut strings which are vibrated by the wind. See ÆOLIAN.

2. An *eölian-attachment* to a piano-forte is a supplementary arrangement of a bellows and set of reeds which are called into action at the discretion of the performer.

E-o'li-pile. The rotary steam-engine of Hero. See ÆOLIPILE.

E-paule'. (*Fortification.*) The shoulder of a bastion; the salient angle formed by the face and flank.

E-paule'ment. (*Fortification.*) A species of breastwork formed to defend the flank of a post or any other place.

A work thrown up to defend troops from an attacking force; usually shoulder-high, hence the name epaulement.

E-pergne'. An ornamental stand for a large dish on a table.

Ep'i-cy'clic Train. (*Gearing.*) An epicyclic train is one in which the axes of the wheels revolve around a common center. They are used for various purposes. Several are shown under the heads EQUATIONAL BOX; SUN AND PLANET MOTION; PARALLEL MOTION; EPICYCLOIDAL WHEEL, etc.

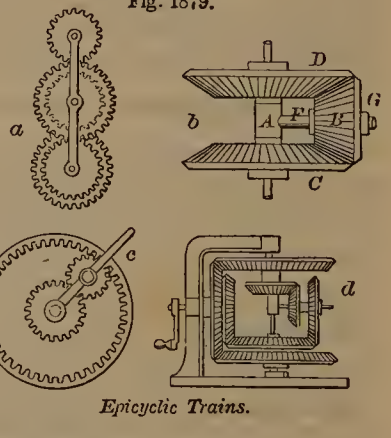
Their forms are numerous, curious, and ingenious. (See page 120, Brown's "Five Hundred and Seven Mechanical Movements.") Quite a number of applications of the device have been made to harvesting-machines, in transmitting the motion of the driving-wheel axle to the cutter-bar.

a b c d are forms of epicyclic gearing.

The epicyclic train *b* has some features in common with Houldsworth's equational-box for regulating the relative speeds of the spindle with its flyer, and the bobbin, in the roving-frame.

If motion be imparted at the same speed and in the same direction to the loose wheels *D C*, the effect is to revolve *B* around the shaft *A* without rotating *B* on its axis *F G*; they all move together as if pinned fast in a cluster.

Fig. 1879.



Epicyclic Trains.

If motion be imparted to the loose wheels *D C* at the same speed in opposite directions, the effect is to rotate the wheel *B* on its axis without revolving it on the common axis *A*.

Unequal rates of motion of the wheels *D C*, either in the same or opposite directions, will cause the wheel *B* to rotate on its axis, and with its axis *F G* to revolve around the common center *A*.

In Entwistle's patent gear, three bevel gears of even size are thus associated, and the device is used for steering-apparatus, multiplying speed for screw-propellers, etc.

Driving from the other end of the train gives power with decrease of speed.

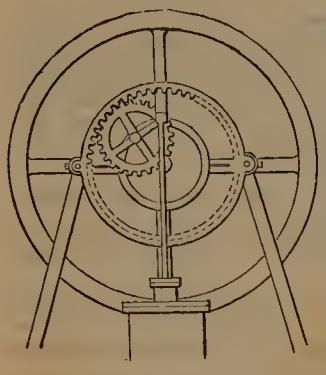
Many ingenious applications of the device might be cited and shown would space permit.

Ep'i-cy-cloid'al Wheel. An epicycloid is a curve generated by a point in the circumference of a movable circle, which rolls on the inside or outside of the circumference of a fixed circle. See SUN AND PLANET MOTION, the invention of Watt.

An epicycloidal wheel is a contrivance for securing parallel motion, in converting reciprocating mo-

tion into circular, depending on the principle that an inner epicycloidal curve becomes a straight line when the diameter of the fixed circle is just double that of the rolling one. It consists of a fixed ring, with teeth on the inside, into which is geared a wheel of half its diameter; to a pin on the circumference of the smaller wheel the reciprocating motion is communicated, while the center of the wheel describes a circle and may receive the pin of a crank whose shaft is concentric with the ring. — WEBSTER.

Fig. 1880.



Epicycloidal Wheel.

Ep'in-glette'. An iron needle for piercing a cannon-cartridge before priming.

E'prou-vette'. 1. An apparatus for proving the strength of gunpowder.

One simple mode is to fire weighed charges and ascertain the range of the balls. A small quantity of powder, a heavy ball, and a short mortar reduce the range within convenient limits.

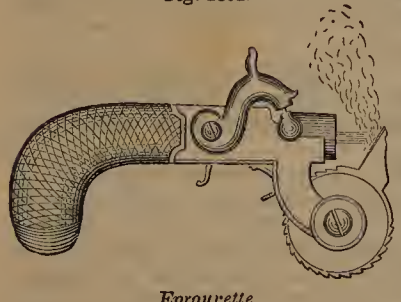
Another is to fire a small quantity beneath a shot attached at the foot of a vertical rod. The latter ascends, and, on reaching its greatest elevation, is prevented from descending by a pawl which engages a rack on the rod. The hight to which the shot ascends determines the strength of the powder.

The éprouvette of Regnier is an adaptation of the Sector dynamometer. A small brass cannon is attached to one arc and charged with a given quantity of powder. A projection from the other arc comes in front of the muzzle, and the parts are separated when the explosion takes place.

A cursor over the graduations indicates the point reached by the force of the explosion. See BALLISTIC PENDULUM.

A convenient and portable éprouvette is an instrument shaped like a small pistol without a barrel, and having the forward end of its charge-chamber closed by a flat plate connected with a spring. On the explosion of the powder against the plate, the latter is driven forward to a distance proportioned to the strength of the powder, and is retained at its extreme range of propulsion by a ratchet-wheel and spring-click.

Fig. 1881.



Eprouvette.

Pouillet's chronoscope and Navez's electro-ballistic apparatus, by measuring the velocity attained by balls with charges of certain powders, form good *éprouvettes*. See CHRONOSCOPE; ELECTRO-BALLISTA.

2. (*Metallurgy.*) A flux spoon. A spoon for sampling an assay.

E'prou-vette'-gun. The gun-éprouvette determines the strength of the powder by the amount of recoil produced. A small piece of ordnance is fastened to a frame which is suspended as a pendulum so as to vibrate in an arc when the piece is fired. A pointed iron rod projects downward from the gun, and travels in a groove of soft wax as the gun recoils, thus making a mark which is measured to determine the length of the arc. A graduated arc with an index-finger is used in the British service. The gun is of brass, $1\frac{3}{4}$ inch bore, 27.6 inches long, weighs $86\frac{1}{2}$ pounds; suspended from a frame and charged with two ounces of powder without shot or wadding.

The éprouvette-mortar of the British service is 8 inches in diameter, and is charged with 2 ounces of the powder, and an iron ball of $63\frac{1}{2}$ pounds weight; average range of 265 feet. The government powder, somewhat deteriorated and reserved for blasting, gives a range of 240 feet.

The French éprouvette-mortar has a caliber of 7 inches; charge, 3 ounces; projectile, a copper globe of 60 pounds; required range, 300 yards.

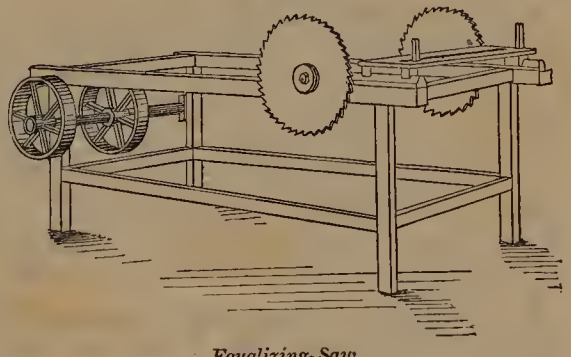
The éprouvette-mortar of the United States service is a 24-pounder, having a chamber to contain one ounce of powder, and no windage to the ball. The required range for new powder, 250 feet.

E'qual-ing-file. A flat file which has a constant thickness, but may taper a little as to width.

E'qual-iz-er. An *evener* or whiffletree to whose ends the *swingle-trees* or *single-trees* of the individual horses are attached. A three-horse equalizer divides the load to three draft-animals. See TREBLE-TREE.

E'qual-iz-ing-saw. A pair of saws on a mandrel at a gaged distance apart, and used for squaring off the ends of boards and bringing them to dimensions.

Fig. 1882.

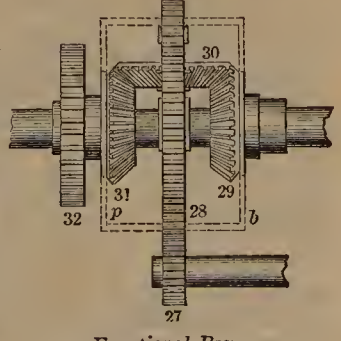


Equalizing-Saw.

E-qua'tion-al Box. Invented by Houldsworth. A differential gearing used in the bobbin and fly machine for the adjustment of different degrees of twist, for different yarns. The bobbin and flyer are driven independently, and the arrangement affords a means of changing the relative speeds.

Two short cylinders *b p* inclose bevel wheels 29 31. Between the edges of these boxes is a spur-wheel 28, driving a third bevel-wheel 30, mounted on an axis forming the radius of the spur-wheel, and occupying a slot in the *web* of the wheel.

Fig. 1883.



Equational Box.

The wheel 30 has the same diameter and number of teeth as the wheels 29 31, with which it engages. The wheel 29 is keyed to its shaft; but wheels 28 31 run loosely on the shaft and independently

of it. Now, if wheel 28 be held still and wheel 29 be turned, the middle wheel 30 will act merely as a carrier between 29 and 31, which will turn with the same speed, but in opposite directions. If 28 be turned at the same speed as 29 and in the same direction, the middle wheel 30 will not revolve on its axis, but acts *as a pin* between 29 and 31, causing them to turn with the same speed and in the same direction. These are the *extreme cases*. The middle case is when 28 turns with half the speed of 29, in which case 31 does not revolve at all. All possible variations between the relative speeds of 29 and 31 can therefore be attained by changes of velocity in 28. This is accomplished by putting a larger or smaller pinion on shaft *K*, which has a regular rate of motion relatively to shaft *B*.

Wheel 32 is joined to 31, and drives the *bobbins*, whose speed is adjusted in any required ratio to that of the spindles and flyers, whatever may be the speed of the latter. See BOBBIN-AND-FLY FRAME.

E-qua'tion-watch. A watch made to exhibit the differences between mean solar and apparent solar time. Originally made in England, but improved in France.

E'qua-to'ri-al. A telescope mounted to follow the apparent motion of the heavenly bodies as they move in the sky. It revolves about an axis so inclined that its motion around it may be parallel to the equator. Hence the name. See TELESCOPE.

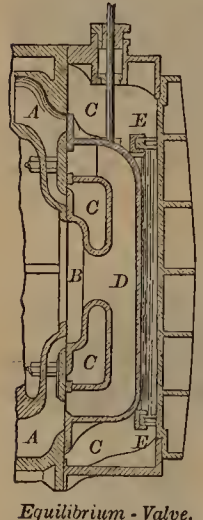
E'qua-to'ri-al Sec'tor. An instrument of large radius for finding the difference in the right ascension and declination of two heavenly bodies.

E'qua-to'ri-al Tel'e-scope. The equatorial telescope is so mounted as to have a motion in two planes at right angles to each other; one parallel to the axis of the earth, and the other to the equator. Each axis has a graduated circle, one for measuring declination and the other right ascension. The right ascension and declination of an astronomical object being known, the telescope may be pointed to the spot. Clock-work is sometimes attached to the instrument to give the motion in right ascension, and thereby keep the object constantly in the field of the instrument.

The large telescopes of the principal observatories are mounted equatorially. See TELESCOPE. See also Fig. 401, p. 175.

E'qui-lib'ri-um-valve. (*Steam-engine.*) *a.* A valve having a pressure nearly equal on both sides, so as to make it more easily worked by nearly neutralizing its pressure on the seat.

Fig. 1884.



Equilibrium-Valve.

The valve *D* has packing on the back opposite to the two ports, so as to exclude the steam from behind it, and thus remove the pressure thereof.

A, cylinder ports.

B, central port leading to condenser.

C, parts of the valve-casing filled with steam.

D, equilibrium-valve.

E, packing ring on the back of the valve.

b. The valve in the steam-passage of a Cornish engine for opening the communication between the top and bottom of the cylinder, to render the pressure equal on both sides of the piston.

E-ras'ing-knife. A knife with a cordate blade, sharpened on each edge, and adapted for erasing marks from paper by an abrading or cutting action, according to the angle at which it is held. The ends are provided with burnishers, rubbers, pencil-sharpeners, or other appendages useful about the desk. An *eraser*.

E-rect'ing Eye-piece. (*Optics.*) A combination of four lenses used for terrestrial telescopes, and so arranged as to exhibit the objects viewed in an erect position. This is not deemed necessary in astronomical telescopes, as the additional lens required causes the reflection and absorption of a certain portion of light.

E-rect'ing-glass. A tube with two lenses, slipped into the inner end of the draw-tube of a microscope, and serving to erect the inverted image. See ERECTOR.

E-rect'ing-prism. A contrivance of Nachet's for erecting the inverted image produced by a compound microscope, by means of a single rectangular prism placed over the eye-piece.

E-rect'or. An arrangement to antagonize the inversion of the image formed by the object-glass, by again inverting the image to make it correspond in position with the object.

First applied to compound microscopes by Lister. It is a tube about three inches long, having a meniscus at one end and a plano-convex lens at the other, — the convex sides upward in each case, — and a diaphragm about half-way between them. The *erector* is screwed into the lower end of the draw-tube.

E'ri-om'e-ter. An instrument for measuring the diameter of small fibers, such as wool, cotton, or flax, by ascertaining the diameter of any one of the colored rings which they produce.

"The *eriometer* is formed of a piece of card or plate of brass, having an aperture of about one fiftieth of an inch in diameter in the center of a circle of one half inch in diameter, and perforated with small holes. The fiber or particle to be measured is fixed in a slider, and the eriometer being placed before a strong light, and the eye assisted by a lens applied behind the small hole, the rings of colors will be seen. The slider must then be drawn out or pushed in till the limit of the first red and green ring (the one selected by Dr. Young) coincides with the circle of perforations, and the index will then show on the scale the size of the particle or fiber." — BREWSTER'S *Optics*.

Es-cape'. (*Telegraphy.*) Leakage of current from the line-wire to ground, caused usually by defective insulation and contact with partial conductors.

Es-cape'ment. A device intervening between the *power* and the *time-measurer* in a clock or watch, to convert a continuous rotary into an oscillating isochronous movement. It is acted on by each. The *power* imparts through the escapement an impulse to the *pendulum* or *balance-wheel* sufficient to overcome the friction of the latter and the resistance of the atmosphere, and thus keeps up the vibrations. The *time-measurer* (*pendulum* or *balance-wheel*) acts through the escapement to cause the motion of the *train* to be intermittent.

While there is some variation in the trains of clocks and watches, and in other particulars, they are generally named according to the form of their escapement; as, —

Anchor-escapement.	Detached escapement.
Chronometer-escapement.	Duplex-escapement.
Crown-wheel escapement.	Electric-clock escapement.
Cylinder-escapement.	Horizontal escapement.
Dead-beat escapement.	Lever-escapement.

Recoil-escapement. Vertical escapement.
Remontoire-escapement. (Which see.)
Verge-escapement.

Goodrich, in 1799, substituted a crank for an escapement in clocks, and received a bounty of £65 from the London Society of Arts. Its advantage was silence.

A number of curious and ingenious escapements may be found in works on horology, in Denison's volume in Weale's series; Brown's "Five Hundred and Seven Mechanical Movements"; and Piaget's "The Watch; its History and Manufacture."

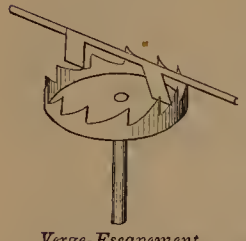
Es-cape'-valve. (*Steam-engine.*) *a.* A loaded valve fitted to the end of the cylinder for the escape of the condensed steam, or of water carried mechanically from the boilers with the steam. A *priming* valve.

b. Escape-valves are also fitted to the feed-pipes as a means of exit for the surplus water not used by the boilers.

c. A valve which affords escape to steam in a given contingency; upon excessive pressure by a safety-valve; to announce low-water, etc.

Es-cape'-wheel. These are various in form; the wheel is acted upon by the spring or weight of the clock or watch, and is allowed an intermittent rotation, one tooth at a time, and the pendulum or balance-wheel which thus regulates the movement becomes the time-measurer. The pallets on the oscillating pendulum arbor allow the teeth to escape, one at a time. See ESCAPEMENT.

Fig. 1885.



Verge-Escapement.

Es-carp'. (*Fortification.*) A wall on the inside of the ditch at the foot of the rampart. On the other side of the ditch is the *counterscarp.*

Es'cri-toire'. A writing-desk; generally fixed, and having a falling leaf.

Es-cutch'eon; Scutch'eon. An ornamental plate for a name, as in a *coffin-plate*, the *name-plate* on the side of a pocket-knife, etc.; or a perforated plate to finish an opening, as the *key-hole plate* of a door, drawer, or desk.

E-soph'a-gus-for'ceps. One for removing foreign matters from the gullet.

An esophagus-forceps, with bent shank, was found in 1819, in a house in Pompeii, by Dr. Savenko, of St. Petersburg. It is pictured in Smith's "Dictionary of Antiquities," p. 274.

Es-pal'ier. (*Agriculture.*) A trellis for training vines or other plants.

Es'pla-nade'. (*Fortification.*) An extended glacis. The sloping of the parapet of the covered way toward the open country.

A clear space between the citadel and the adjacent houses of a fortified town.

Es'ta-cade'. (*Fortification.*) A line of pile stakes in water or swampy ground to check the approach of an enemy.

Es-the'si-om'e-ter. (*Surgical.*) An instrument to ascertain the tactile sensibility of the human body. It has two points, adjustable as to distance, and the object is to ascertain the nearest proximity at which the points give distinct sensations. The result is indicative of a normal or abnormal condition of the surface. In front of the ear the points may be three quarters of an inch apart, and give but a single sensation; but if you draw them lightly across the face to the other ear, at a certain point the single sensation will change into a double sensation; as they approach the mouth, they will seem to separate more widely, and on the other side of the face they will seem to draw together again, until the double impression is lost in a single one. (See NERVE-NEEDLE.) An anatomist (Rufus, of Ephesus) dissected apes and distinguished between nerves of sensation and of motion.

Es-trade'. A slightly raised platform, occupying a part of a room. It may form a *dais.*

Et'a-gère'. A set of shelves in the form of an ornamental standing-piece of furniture. Used for the display of articles of bijouterie and vertu.

Etch'ing. 1. (*On metal.*) Engraving executed by a pointed tool and acid upon a metallic or glass surface previously covered with varnish.

The ordinary procedure is as follows: Cover a polished metallic plate with a composition technically called *ground*, and consisting of asphaltum, 4 parts; Burgundy pitch, 2 parts; white wax, 1 part. For use, this is melted and compounded, and tied up in a silk rag. The plate is heated, rubbed with the ground, which is then spread evenly, smoked, and allowed to cool.

The design is traced by a pointed tool, called an etching-point, which lays bare the metal wherever it goes. This finished, a wall of wax is raised around the design to hold the dilute acid which is poured on. For a copper-plate, this consists of nitrous acid, 1 part; water, 5 parts. For steel, pyroligneous acid, 1 part; nitric acid, 1 part; water, 6 parts. This is poured on the plate, which it corrodes on the lines made through the "ground." This is called "biting-in." The etching is swept with a feather to remove the bubbles from the surface, or, in case of a steel-plate, agitation may answer the purpose. When a sufficient depth is attained for the lighter tints of the etching, the acid is removed, the surface washed and allowed to drain dry. The parts having sufficient depth are now "stopped out" by a varnish of Brunswick-black laid on with a camel's-hair brush. When the varnish is dry, another "biting-in" will deepen the lines of the parts not "stopped out," and when these parts are deep enough for the second tint, the varnish is removed, the plate dried, etc. This is repeated as many times as may be necessary.

The wall of wax is then removed, the surface of the plate cleaned with turpentine, and the plate is sent to the printer for a proof of the etching, which is complete. It may be finished by a graver to give it more effectiveness, but it then partakes of the character of a line engraving.

Etching is *all* accomplished by the point and acid.

The art is believed to have originated in Germany, judging by its name *etzen;* but the earliest known practitioners were Albert Dürer, a German, and Agostino Veneziano and Parmegiano, Italians. These were contemporaries.

Etching on soft ground is in imitation of chalk or pencil drawing, but has been abandoned since lithography has attained excellence. The soft ground is made by adding one part of hog's lard to three parts etching *ground* (see GROUND), which is laid on the plate with the dabber in the usual way. A piece of smooth writing-paper, having the design in outline, is damped and stretched over the plate. A pencil is then used to follow the lines of the design, observing that the softer the *ground* the softer the pencil should be. The temperature of the season or the room will affect the character of the *ground.* When the paper is removed, it withdraws the adhering lines of ground, and the plate is *bitten-in* in the usual way.

Several peculiar processes have been introduced in etching, but are rather curious than useful.

Electro-etching, so called, is a process of *biting-in*, rather than *etching*, and consists in exposing the etched plate in the electro-bath, as the copper of the battery, so as to be corroded by the voltaic action. See ELECTRO-ETCHING.

Daguerreotype-etching is a process wherein the dark lines of the image in the camera are made to expose the plate to the action of acid.

One mode of etching, the reverse of the usual plan, is to remove with point and scraper the lights, and then bite-in so as to expose the design in relief.

2. (*Glass.*) Fluoric acid was discovered by Scheele in 1771. One hundred years previous to this, Schwanhard had a secret process for etching glass, but his secret died with him. See ETCHING ON GLASS.

3. (*Lithographing.*) *a.* The preparation of a lithographic stone with a weak mineral acid after the drawing or transfer has been put upon its surface; the object being to fix and render such drawing capable of receiving the ink used in printing. The crayon or ink of the artist is essentially based upon an alkaline soap combined with wax, resins, and pigment, the latter being added merely for the purpose of enabling the artist to see the progress of the work; drawings made with crayons and the ink used in pen-work are soluble, and hence not fit to resist the damping process on the stone; nor is the stone under them fit to receive the printing-ink. The action of a very weak acid applied to the stone by a large soft brush, a sponge, or by flooding it, is to decompose the alkaline soaps, forming nitrates or chlorides of the alkaline metals, according to the acid used, and setting free the stearic and oleic acids simultaneously. These fatty acids isolated in intimate contact with the carbonate of lime, of which the stone is mainly composed, appear to enter into chemical combination with the same, driving out the carbonic acid. The insoluble lime-soap thus formed has an exceedingly strong affinity for greasy matters of all kinds, and readily accumulates upon its surface the "varnish" (burned linseed-oil) constituting the vehicle carrying the carbonaceous matter which gives the printing-ink its color.

Another function of the weak acid is performed upon the clean part of the stone, whereby it renders the particles of calcareous matter peculiarly susceptible to receiving and holding, despite the long-continued damping operations upon the stone, the covering of gum-arabic furnished by the operation of GUMMING (which see). The gum is often applied with the acidulous solution. Sulphuric acid cannot be used in etching, in consequence of the production of insoluble sulphate of lime.

b. Etching by a needle or diamond on stone is done in two ways: —

1. The surface of the stone is treated with gum and acid (an ink-resisting compound), and dried; the work is then scratched in by the etching-point. Oil is rubbed over the surface, which is resisted by the gum, but penetrates where the stone has been laid bare by the needle. The stone is then washed off, rolled up and printed. This is usually called engraving.

2. The surface of the stone is covered with an asphaltum ground; the work is etched in, cutting away so much of the ground and exposing the stone. Acid is then applied, which eats away the stone, making a depression; this is inked, the asphaltum cleaned off, the clear spaces etched, and gummed as usual in the lithographic process.

Etch'ing-nee'dle. A sharp-pointed instrument for scratching away the *ground* on a prepared plate, preparatory to the *biting-in*.

Etch'ing on Glass. This art was invented by Schwanhard of Nuremberg, 1670, and originated in an accident to his spectacles, which became corroded by some drops of acid. Fluoric acid, discovered by Scheele, 1771, is now employed for corroding, or, as it is technically called, "biting-in" the etching. The glass is covered with a resinous ground, and the design marked by an etching-point, exposing the glass. The latter is then subjected to an acid, which acts upon the silicate and eats away the glass at these points, making depressions which constitute the etching.

Etch'ing-point. The steel or diamond point of the etcher.

Etch'ing-var'nish. A compound of wax, asphaltum, pitch, etc., for spreading on plates which are to be etched. See GROUND.

E'ther-en'gine. See BISULPHIDE OF CARBON ENGINE; AIR-ENGINE; GAS-ENGINE.

E-tui'. A case for holding small articles, as a lady's work-box and case for articles of graceful needle-work.

Eu'di-om'e-ter. Dr. Priestley, the discoverer of oxygen gas, devised the first *eudiometer*, for ascertaining the quantity of oxygen contained in a given bulk of aëriform fluid.

His device was founded upon the idea of subjecting a measured volume of air to a substance which would *absorb* the oxygen of the air. For this purpose he used deutoxide of nitrogen, which has an energetic tendency to regain the oxygen of which it has been deprived, and resume its condition as nitric acid.

Scheele's eudiometer was a tube of known capacity, in which a body of air was exposed to a mixture of sulphur and iron filings made into a paste with water. This abstracted the oxygen of the air, but an evolution of hydrogen somewhat marred the accuracy of the result.

De Marte used as an oxygen absorbent a solution of sulphuret of potassium.

Guyton used the same material, and added heat to expedite the result. See "Nicholson's Journal," 4to, Vol. I.

Seguin used a glass tube filled with and inverted in mercury. A piece of phosphorus, being introduced, floated to the top of the mercury, and was melted by the approach of a hot iron. Air is then introduced in instalments, and, igniting the phosphorus, parts with its oxygen thereto. A measured quantity having been thus introduced, the remainder in the tube is transferred to a graduated tube, and the loss of bulk by oxidation is determined.

Berthollet used the slow combustion of phosphorus, dispensing with the application of artificial heat.

Hope contrived a *eudiometer* in which a graduated tube containing a cubic inch of air was inverted into a phial containing the oxygen-absorbing solution. The apparatus, being tight, permitted the contents to be agitated. As gas was absorbed, water was admitted to the phial, and the rise of the liquid in the graduated tube indicated the amount of the gaseous remainder.

Henry substituted a caoutchouc ball for the phial in Hope's instrument.

Pepys made a number of technical improvements, which he considered insured accuracy, but certainly complicated the apparatus.

Volta introduced an instrument which superseded the preceding. He determined the composition of the air by combustion with a known quantity of hydrogen gas.

It is founded on the principle that when a mixture of oxygen and hydrogen gases is fired, one third of the diminution is owing to the condensation of oxygen. For this purpose he used a graduated tube and two platinum points, between which an electric spark was caused to pass.

This was modified in construction by Mitscherlich and others, retaining the main idea.

Ure's eudiometer is founded on the Volta principle, but is much simplified in point of manipulation.. It consists of a graduated glass siphon whose open extremity is slightly flaring. The other end is closed, and has two platinum wires. Being filled with water or mercury, the closed leg receives a volume of gas by the ordinary means. A couple of inches of water being displaced from the open end of the tube, the mouth is closed by the thumb, and the instrument approached to the electric conductor, a spark from which, leaping the interval between the end wires, explodes the gases. The rise of the water in the closed end indicates the volume removed, and the result is determined, as before explained, by reference to the graduated tube. If merely oxygen and hydrogen gases have been introduced in their proper atomic proportions, eight of the former and one of the latter, by weight, the result will be water without gaseous remainder.

Fig. 1886.

Ure's Eudiometer.

If the experiment be as first stated: A given volume of hydrogen introduced in company with a body of atmospheric air to be tested; one third the amount of condensation may be ascribed to the removal of oxygen, whose proportions for combining with hydrogen to form water are, oxygen 1, hydrogen 2, by bulk.

The space between the thumb and the surface of the water in the open leg forms an air-cushion when the gases explode.

Döbereiner's is founded upon the power of spongy platinum to cause the combination of oxygen and hydrogen gas. The labors of Bunsen, Regnault, and Reiset, Williamson and Russell, Franklin and Ward, have brought the instrument to the present efficient form.

Eu'phroe. A long slat of wood, perforated for the passage of the awning-cords which suspend the ridge of an awning. The *euphroe* (or *uphroe*) and its pendent cords form a *crow-foot*.

Eu'style. (*Architecture.*) That style of intercolumniation in which the space between the columns was 2½ times their diameter; so called from being considered the most beautiful style.

E-vap'o-rat'ing-cone. A Belgian evaporator, consisting of a hollow cone with double walls, between which is a body of steam. Over the inner and outer surface of the cone a saccharine solution runs in a thin film, and is thereby heated. It is similar in principle to the *Degrand condenser*. See CONDENSER; EVAPORATOR.

It is the same in its principle of construction as certain coolers, in which a refrigerating liquid fills the jacket, over whose walls passes the liquid to be cooled.

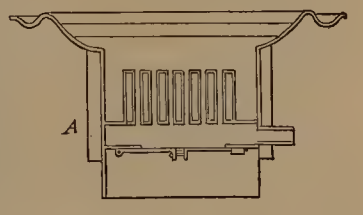
E-vap'o-rat'ing-fur'nace. The furnace of a boiler for cane-juice, sirup, brine, etc.

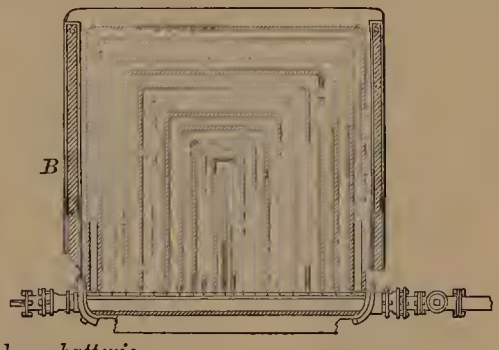
E-vap'o-ra'tion-gage. A graduated glass measure, with wire-gauze cover to prevent access of insects, to determine the ratio of evaporation in a given exposure.

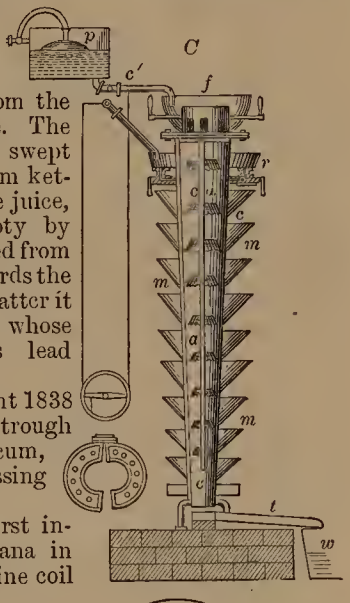
E-vap'o-ra-tor. An apparatus consisting of a furnace and pan, in which vegetable juices are condensed. The varieties are numerous: intended for the sugar-house of the plantation, that of the refinery; for maple-sugar making and for sorghum; for making vegetable extracts for medicines and other purposes. Those which boil *in* (partial) *vacuo* are known as VACUUM-PANS (which see). Some drive off a part of the aqueous fluid, and are called *condensers*, such as the Degrand. See CONDENSER.

A "set of kettles" in Louisiana consists of five, placed in line, and with their tops on the same level. Underneath is a furnace, the mouth of which is outside the building. The kettles are technically known as the *grande*, *propre*, *flambeau*, *sirop*, and the *batterie*. The *grande* receives the cane-juice from the mill, and is the farthest removed from the mouth of the furnace. The scum, as it rises, is swept towards the rear from kettle to kettle, and the juice, as the kettles empty by evaporation, is dipped from one to the other towards the *batterie*. From the latter it is dipped into a box whose conducting troughs lead it to the *coolers*.

Fig. 1887.





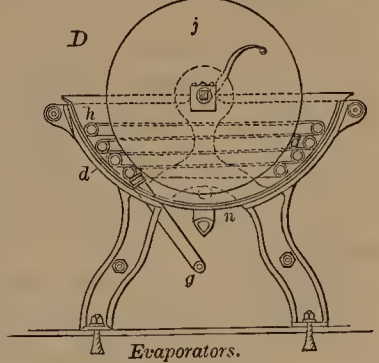


Hoard's pan, patent 1838 (*A*, Fig. 1887), has a trough around to collect scum, and tubular flues passing through the boiler.

The steam-pan, first introduced in Louisiana in 1829, had a serpentine coil at the bottom of a circular pan.

Stillman's pan (*B*), 1846, had a series of bends connecting with a tube which also formed an axis for the system which could thus be erected so as to expose the bottom of the pan.

A combination of the open pan and vacuum-pan has been adopted to some extent in Louisiana, and



Evaporators.

probably elsewhere. The cane-juice being concentrated in open kettles to about 26° or 28° Baumé and then finished in the vacuum-pan. It requires no special notice.

The Duplessis plan, 1846, consists in heating the juice in pans with double bottoms, forming steam-jackets, and then finishing it in kettles let into the top of a horizontal cylindrical boiler, which is pierced with holes for that purpose. The flanges of the kettles are bolted steam-tight to the top plate of the steam-boiler, which has an inclination from front to rear to facilitate the transfer of the scum to a trough at the lower end.

Graham's apparatus, 1843, has a series of kettles in a rising order towards the rear, like steps, so that the *grande* may empty into the *flambeau*, that into the *sirop*, and the latter into the *batterie*, without dipping. They are of progressively smaller size to the lower end of the series, and are heated by steam-jackets. The pans are connected by pipes furnished with stop-cocks.

A connected history of the process of manufacturing sugar is given under SUGAR-MANUFACTURING, and some things are omitted in this to avoid duplication. See also CONDENSER, DEGRAND, which acts as an evaporator of the sirup poured over it, while it condenses the vapor from the vacuum-pan with which it is charged. See VACUUM-PAN.

The Wetzel pan is heated by steam. It is a long tank with a semi-cylindrical lower portion in which revolves a hollow wheel heated by a constant flow of steam. Drums on the shaft are also full of steam, and are connected by pipes, steam-heated. Revolving slowly, it exposes a considerable surface to and agitates the sirup, which constantly drips off that portion exposed to the air.

The Bour pan is somewhat similar, but the revolving, heating surface is made up of steam-heated drums on a shaft, revolving in a pan having a semi-cylindrical well.

The evaporating cone *C* of Lembeck, near Brussels, consists of a double-walled cone *c c* about 16 feet high, and heated by steam in the space intervening between the walls. Sirup from the cistern *s* flows by the faucet *c'* into the funnel *f*, and thence is distributed by openings so as to run in a thin film over the interior surface of the cone *c*. A ball-cock keeps a constant level in the cistern *p*. To prevent the liquid running in streams down the surface of the cone, it is again and again arrested by the hollow conical frustums, which divide any trickling streams and redistribute them over the heated surface. These frustums are strung upon a stem *a a*, so as to be removed in a body when required for cleansing.

The exterior surface of the cone receives a film of the sirup from the same cistern, the spout conducting it into the trough *r* from whence it reaches the surface of the cone. It is again and again arrested by exterior funnel-shaped troughs *m m*, and allowed to trickle therefrom at openings along the meeting edge of the trough with the cone. This breaks up any determination to run in streams, and keeps the evaporating surface evenly supplied.

An annular reservoir receives the condensed liquid, whence it is conducted by a spout *t* to a cistern *w*.

The apparatus is especially designed for beet-root sugar-making.

The Degrand or Derosne condenser is an evaporator used in the cane-sugar works, and consists of a column of horizontal, steam-heated pipes over which the cane-juice trickles, and eventually passes in a condensed condition into a cistern below. See CONDENSER.

A class of inventions known as *coolers* agree in many points of construction with these surface condensers; the main difference being in the fact that in one case the hollow trunk is filled with a refrigerating liquid and in the other with steam. Useful hints may be taken from BEER-COOLERS; LIQUID-COOLERS (which see).

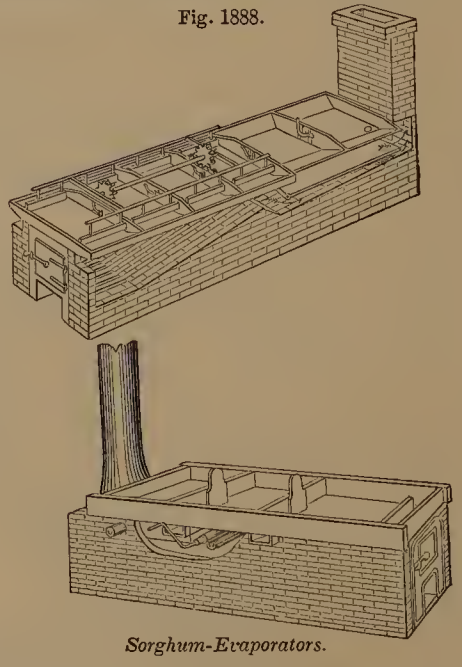
One form of apparatus consists of a number of hollow disks of lenticular figure, arranged upon a common axis, and dipping into the liquid to be evaporated. These disks, or lenses, are constructed of thin metal, and are all in communication with each other through the common axis, which is likewise hollow. The whole system is kept in slow rotary motion by some convenient moving power, and each disk carries up with it, adhering to its surface, a thin film of the liquid; as evaporation when it takes place without ebullition goes on with a rapidity proportional to the surface exposed.

Of this class is Schroder's evaporator *D*, used in the West Indies, for evaporating saccharine juices at a temperature not exceeding 180°; it is worked by hand or steam power. It is intended specially as a substitute for the *teache*, and consists of a semi-cylindrical pan *h*, whose contents are heated by a steam coil *d d*, connecting by pipe *g* with the boiler.

On a longitudinal axle resting in boxes on the ends of the pan are a number of disks *j*, which are rotated by power applied to the crank. As these disks are alternately exposed to the sirup and to the air, the latter has free access to the moistened surface, and carries off the aqueous particles with considerable rapidity. *n* is the discharge-pipe, which is opened by a faucet in the usual manner. The machine stands isolated on the floor of the sugar-house, and is supported on an iron stand.

A modification of this plan is the Cleland evaporator (English), in which the rotating device consists of a spiral coil of steam-pipe receiving steam through the trunnions and immersed during a portion of its revolution in the sirup of the pan. It differs from the *Schroder* pan in the fact that the rotating device is hollow and steam-heated so as to make the action more energetic, the film of sirup on the coil being exposed to the heat of the interior steam and to the evaporative action of the surrounding atmosphere.

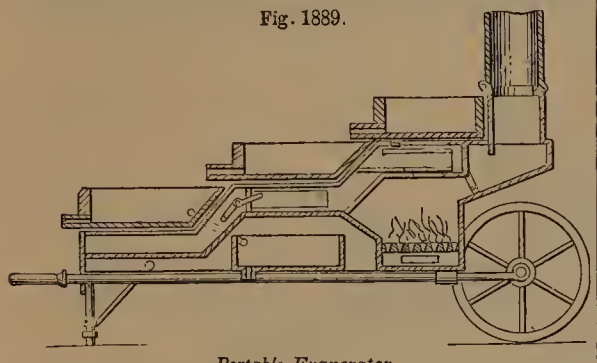
Fig. 1888.



Sorghum-Evaporators.

Fig. 1888 shows two forms of sorghum-evaporators, in the upper one of which are reciprocating paddles for removing scum from the heated juice and sweeping it towards the cooler overhanging shallower parts at the edges of the pan. The lower

Fig. 1889.



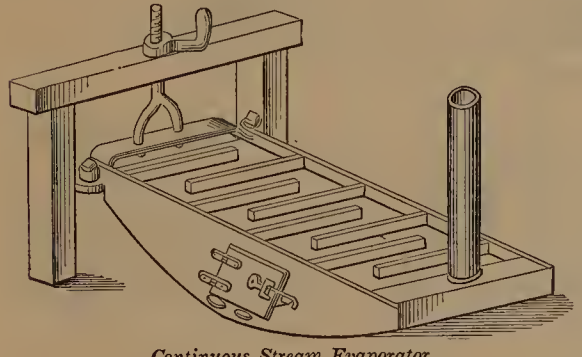
Portable Evaporator.

figure shows a series of pans with connecting apertures stopped by gates.

Fig. 1889 shows a portable evaporator mounted on a wheelbarrow.

Fig. 1890 shows an evaporator in which a continuous stream of juice is allowed to flow in a sinuous track from end to end of the pan, which is

Fig. 1890.

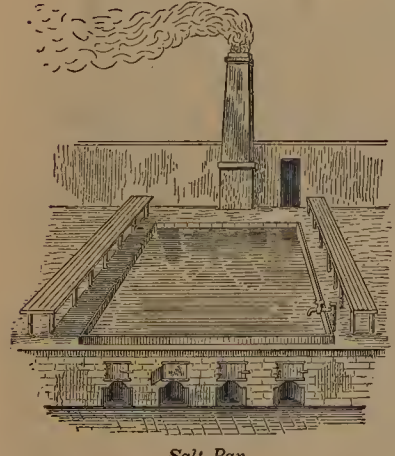


Continuous-Stream Evaporator.

so mounted as to be inclined in any required degree, according to the condition of the fire or of the juice, so that it may reach the end in the desired condition of condensation.

A pan for the evaporation of water from brine is

Fig. 1891.



Salt-Pan.

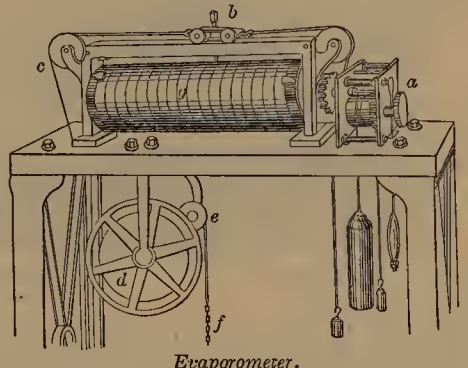
an oblong square, and may have a depth of 12 to 16 inches, and an area of 20 × 40 feet. The pan is made of sheet-iron, supported on the division walls between the furnaces, which are in number proportioned to the width of the pan. The fire from the furnaces is conducted to heat-ovens before being discharged into the chimney. The brine is led into the pan by pipes, and under ordinary circumstances may be twice changed in twenty-four hours. As soon as most of the water has been evaporated, the wet salt is ladled into conical baskets which are placed against the bench to drain. The salt is finally dried in the ovens heated by the furnace fires.

The cocoa-nut palm yields a juice (*suri*), which is evaporated to make a sugar (*jaghery*), one gallon of *suri* yielding a pound of *jaghery*. This is five times the quantity to the gallon that is yielded by the sugar-maple. The suri is obtained by cutting the spadix of the tree and collecting the juice in a crock suspended from the spathe.

E-vap'o-rom'e-ter. An *atmometer* or *hygroscope*, for ascertaining the evaporation of liquids.

The example shows a self-recording evaporometer or tide-gage, adapted also for a rain-gage or to indicate the rise and fall of any body of water in a river, canal, or lock, showing the exact time at which any increase or reduction of level may have occurred.

Fig 1892.

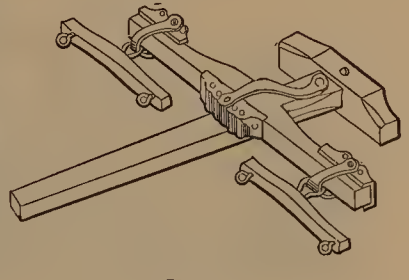


Evaporometer.

a is a time-piece driving the paper cylinder *g*; *b* is the carriage which carries the tracing-pencil that marks the paper on the cylinder, and is moved by the float which is suspended from the card *f* and rests on the surface of the water. The motion of the float is communicated by cord *f* over small wheel *e*, float-wheel *d*, and pulley *c*.

E'ven-er. A double or treble tree, to "even" or divide the work of pulling upon the respective horses. It is swiveled to the pole, usually by a bolt or wagon hammer, and has clips on the ends to which the middle clips of the single trees are attached.

Fig. 1893.



Evener.

Ev'er-point'ed Pen'cil. A pencil-case having a fine cylinder of graphite, which is brought forward by a screw as fast as wear renders it necessary.

Patented by Hawkins and Mordan, England, 1823. The pencil-case has a slider actuated by a screw to project a little cylinder of black-lead as the latter wears away. The lead is so small in diameter that it does not need cutting for the ordinary purposes of a pencil. The projection of the lead is performed by holding the nozzle in one hand and turning round the pencil-case with the other.

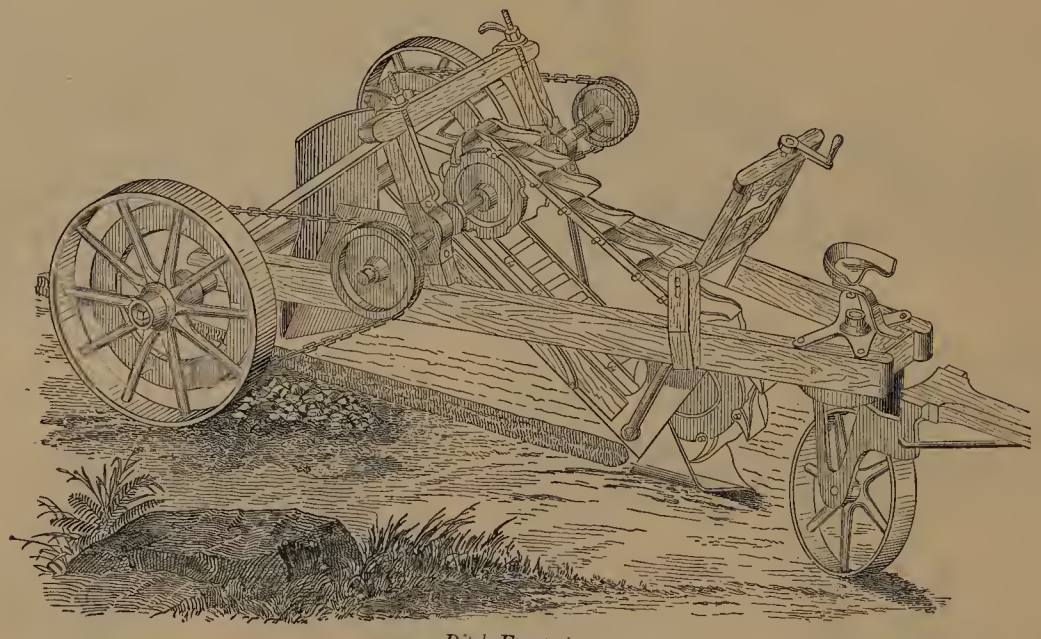
A reservoir at the end of the holder contains a supply of spare leads.

Ew'er. A toilet-pitcher with a wide spout.

Ex'ca-va tor. 1. A machine for digging earth and removing it from the hole. This definition does not distinguish the *excavator* from the *ditching-machine*, *auger*, *dredge*, *earth-borer*, *post-hole digger*, etc. Custom, however, confines the term *excavator* to a narrower range.

The excavator, which is of the nature of a plow, with an elevating earth-belt, is shown in Fig. 1894. It has adjustment for depth of cut, and the dirt ex-

Fig. 1894

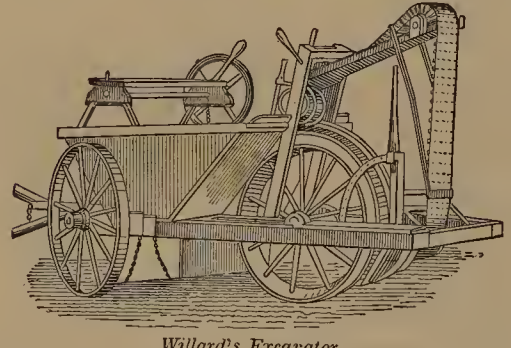


Ditch-Excavator.

cavated by the hollow share is carried upwardly and backwardly by the shovel-belt and dropped into the chute, which discharges it at the side of the trench.

Willard's excavator, which has been so widely used in making railway embankments in the broad West, is shown in Fig. 1895. Its principal use in practice has been to dig soil by the side of the track and dump it on to the road, to form a bed for the ballast and sleepers. The earth is scraped up by the shovel, carried between the wheel and a traveling apron, and dropped into a hopper. When this is full, the ma-

Fig. 1895.



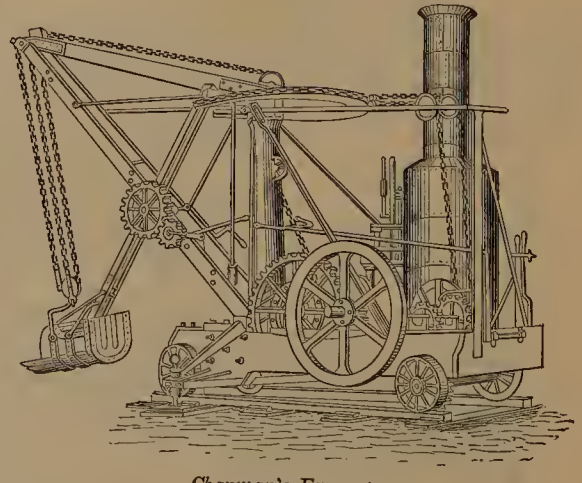
Willard's Excavator.

chine is drawn on to the site of the road and the load dumped.

The excavator (Fig. 1896) is mounted on a carriage which traverses on a temporary track. At one end of the frame is a crane, which has a circular adjustment on its axial post. To the end of the chain-tackle is suspended a scoop made of boiler-iron, whose lip is a steel edge with fingers. Direction is given to the scoop by means of a beam which may be called the scoop-handle, and when the scoop has been thrust by its weight into the earth, the beam affords a fulcrum on which the scoop rotates when the tackle-chain is wound up on the drum by the action of the steam-engine.

The excavated earth along some parts of the line of the Suez Canal was transported by means of a pump. By the aid of a steam-pump water was mixed with the earth brought up by the dredge, and

Fig. 1896.



Chapman's Excavator.

the mud so formed was spouted out upon both banks of the canal to such a distance and in such quantities as to form high compact ramparts against the sand showers blowing in from the desert. Ninety-six million cubic yards of earth have been taken out; and there is left to-day a canal 90 miles long, 328 feet wide at the surface, and 74 feet wide at the bottom, and 26 feet deep throughout. See DREDGING-MACHINE.

The practice adopted in the United States, in France, in England, and Holland is to mix such earth *in situ* and pump it up, — mud, earth, sand, and all, — and pour it into lighters or directly upon the land adjacent.

The hydraulic mining of California is by means of powerful jets of water projected against the banks of drift, the *débris* of former periods of glacial and fluvial action. See AUGER; DITCHING-MACHINE; DREDGING-MACHINE; SCRAPER; WELL-BORING.

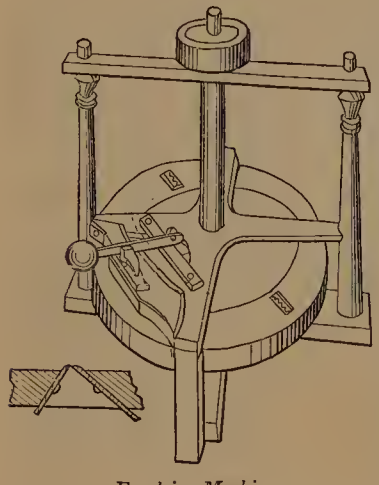
Number of Cubic Feet of various Earths in a Ton.

Loose earth	24
Coarse sand	18.6
Clay	18.6
Earth with gravel	17.8
Clay with gravel	14.4
Common soil	15.6

2. A dentist's instrument for removing the carious portion of a tooth. They are of various forms and sizes, straight, curved, angular, and hooked; and may be compared to chisels, gouges, scrapers, scrapers; spear, hoe, hatchet, spade or spoon shaped, etc.

Ex-cel'si-or. A trade name for curled shreds of wood used as a substitute for curled hair in stuffing cushions, etc.

Fig. 1897.



Excelsior-Machine.

It is made in a machine in which the bolt is pressed downward within its fixed case by a weighted lever, and subjected to the action of the scoring and plane cutters at the upper surface of the horizontal rotating wheel.

Ex-change'-cap. A fine quality of paper made of new stock; thin, highly calendered, and used for printing bills of exchange, etc.

Ex'cla-ma'tion. Note of. A mark (!) indicating emotion or pointed address; as —

"Father of all!"

Ex-e'dra. (*Architecture.*) A niche projecting beyond the general plan of a building.

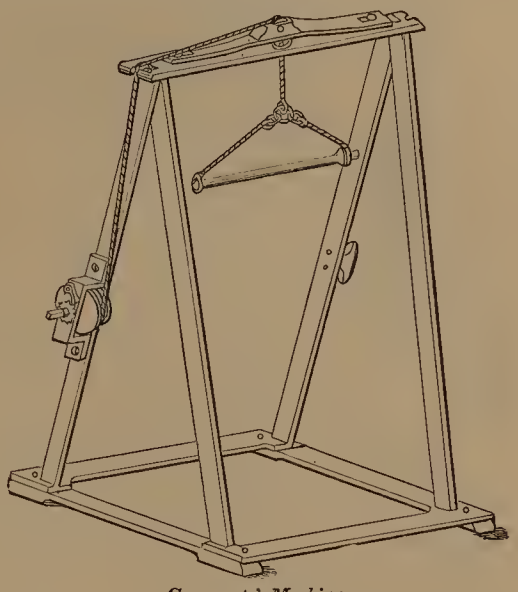
Ex'er-cis'ing-ap'pa-ra'tus. An apparatus for the use of gymnasts, or for the training of special muscles. In the example, the hand-bar is supported on an adjustable cord passing over a spring. The frame has two spring-boards near the floor.

In other instances the apparatus is intended for the use of those unable to take walking exercise. The bedridden patient uses the arms to flex and extend the legs and keep the body in motion, the bedstead rocking on its centers.

Lounde's English patent, 1796, described a *gymnasticon* with treadles for the feet and cranks for the arms. It is adapted to exercise a limb which may have no voluntary motion, and may be used by a patient sitting, standing, or lying.

Ex-haust'er. (*Gas-making.*) An apparatus by which reflex pressure of gas upon the retorts is prevented. The forms are various; one consists of a

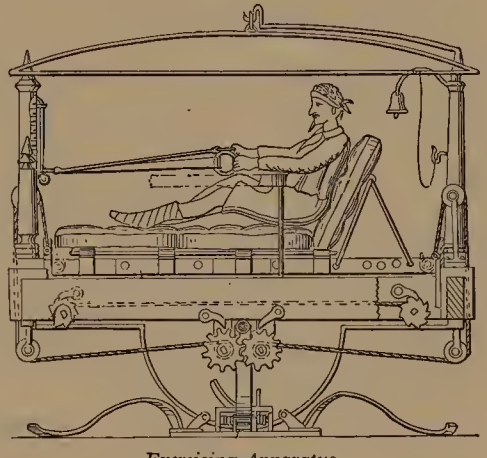
Fig. 1898.



Gymnasts' Machine.

device like one form of rotary steam-engine, which has an eccentric, revolving hub and sliding piston

Fig. 1899.



Exercising-Apparatus.

in a cylindrical chamber. It is of the nature of a rotary pump.

Ex-haust'-fan. One in which the circulation is obtained by *vacuum*, in contradistinction to that which acts by *plenum*, forcing a body of air into and through a chamber or passage-way. See BLOWER; FAN.

Ex-haust'ing-syr'inge. A syringe with its valves so arranged as to withdraw the air from the object to which it is applied.

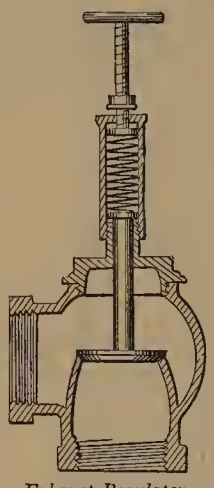
Ex-haust'-port. (*Steam-engine.*) The passage leading from the cylinder to the condenser or to the open air.

Ex-haust'-pipe. One conducting the spent steam from the cylinder.

Ex-haust'-reg'u-lat'or. A valve adjusted to the pressure of the steam by compressing or relaxing the spring held within the tube, by means of a disk secured to the end of the spindle, the object being to utilize the exhaust steam.

Ex-haust' Steam. (*Steam-engine.*) Steam which passes out of the cylinder after having performed its function. It is emitted by its own pressure when the exhaust valve is opened, and its ejection is

Fig. 1900.



Exhaust-Regulator

assisted by the advancing piston, which is being driven by the *live steam* behind it.

Ex-haust'-valve. (*Steam-engine.*) The valve which governs the opening by which steam is allowed to escape. The *eduction-valve.*

The valve in the eduction passage of the steam cylinder of a Cornish engine, placed between the cylinder and air-pump, and worked by the tappet motion, so as to open shortly after the equilibrium-valve, and admit the steam to the condenser.

Ex-pand'ing-al-loy'. Such as expands in cooling. They always contain bismuth, and usually antimony. Type-metal is a familiar instance.

Ex-pand'ing-ball. One having a hollow conical base, affording a relatively thin body of metal, which is expanded by the force of the explosion, driving it closely against the bore of the gun and into the rifling, preventing windage.

Ex-pand'ing-bit. A boring-tool whose diameter is adjustable. See AUGER; BIT.

Ex-pand'ing-drill. One having a pair of bits which may be diverged at a given depth to widen a hole at a certain point; used in drills for metal and for rock-boring.

Ex-pand'ing-man'drel. One having fins expansible in radial slots to bind against the inside surfaces of rings, sleeves, or circular cutters placed thereon.

Ex-pand'ing-plow. One having two or more shares, which may be set more or less distant, according to the distances between the rows at which different crops are planted.

Ex-pand'ing-pul'ley. One whose perimeter is made expansible, as a means of varying the speed of the belt thereon. See EXPANSION-DRUM.

Ex-pand'ing-ream'er. One which has a bit or bits extensible radially after entering a hole, so as to enlarge the hole below the surface.

Ex-pan'sion. 1. The expansion and contraction of long beams from changes in temperature is shown by the following table, which exhibits the extension dilatation in passing from 32° to 212° Fah. (0° to 100° centigrade).

The table exhibits the expansion at 212°, the length of the bar at 32° = 1.

Bismuth	1.00139
Brass	1.00216
Copper	1.00181
Bronze	1.00184
Gold	1.0015
Cast-iron	1.00111
Wrought-iron	1.00125
Steel	1.0011
Lead	1.0029
Platinum	1.0009
Silver	1.002
Tin	1.002
Zinc	1.00294
Brick, common	1.00355
Brick, fire	1.0005
Cement	1.00143
Glass (average)	1.0009
Granite	1.0008
Marble	1.0011
Sandstone	1.0017
Slate	1.00104
Pine (along the grain; dry)	1.000428
Honduras Bay wood (along the grain; dry)	1.000461
Water at 40° = 1	1.0401
Air	1.376

2. (*Shipbuilding.*) The expansion of the skin of a ship, or rather of a net-work of lines on that surface, is a process of drafting to facilitate the laying-off of the dimensions and positions of the pieces of which that skin is to be made, whether timber planks or iron plates.

It consists in covering the surface with a net-work of two sets of covers, which cross each other so as to form four-sided meshes; then conceiving the sides of those meshes to be inextensible strings, and drawing the net-work as it would appear if spread flat upon a plane. By this operation, the meshes are both distorted and altered in area; the curves forming the net-work preserve their true lengths, but not their true angles of intersection; and all other lines on the surface are altered both in length and in relative angular position.

The process is applied to surfaces not truly developable. See DEVELOPMENT.

3. (*Steam.*) The principle of working steam expansively was discovered by Watt, and was the subject-matter of his patent of 1782. By it the supply of steam from the boiler to the cylinder is *cut off* when the latter is only partially filled, the remainder of the stroke of the piston being completed by the expansion of the steam already admitted.

The work done by a given amount of steam is greater when worked expansively than when worked at full pressure, in the following ratio: —

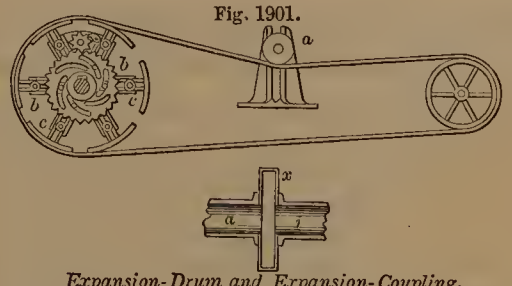
Point of cutting off.	Mean Pressure of Steam.	Gain per Cent in Power.	Point of cutting off.	Mean Pressure of Steam.	Gain per Cent in Power.
.1	3.302	230.	.5	1.693	69.3
.125	3.079	208.	.6	1.507	50.7
.166	2.791	179.	.625	1.47	47.
.2	2.609	161.	.666	1.405	40.5
.25	2.386	139.	.7	1.351	35.1
.3	2.203	120.	.75	1.285	22.3
.333	2.099	110.	.8	1.223	20.5
.375	1.978	97.8	.875	1.131	13.1
.4	1.916	91.6	.9	1.104	10.4

No deductions are here made for a reduction of the temperature of the steam while expanding or for loss by back pressure.

Ex-pan'sion-coup'ling. The coupling represented consists of an expansion-drum of thin copper *x* between the extremities of two pipes *a i*, Fig. 1901, which, in elongating, press the sides of the drum in, and draw them out in cooling.

Ex-pan'sion-drum. An arrangement by which an occasional change of speed may be effected. The diameter of one of the drums is made variable, and the belt is kept strained by means of the weighted roller *a*. The part of the *expansion-drum* marked *b*, consisting of a boss and grooved arms, is keyed fast on the shaft; on to another portion of the arm *c*, which slides up and down, in the groove of *b*, is cast a portion of the circumference of the drum; it has also a stud *d*, fitting into the curved slot of the disk *e*, which moves loose on the boss *b*, and has teeth on its circumference into which works a pinion *f*, with ratchet fixed to the part *b*, and turned with a handle. As the disk is to turned the right or

Fig. 1901.



Expansion-Drum and Expansion-Coupling.

left, the studs move up or down in the curved slots, and the diameter of the drum is increased or diminished.

Ex-pan'sion-gear. (*Steam-engine.*) The apparatus by which access of steam to the cylinder is cut off at a given part of the stroke. A *cut-off.*

A *variable* cut-off is one which is capable of being adjusted while the engine is in motion, to cut off at any given portion of the stroke, within a given range, as the requirements of the work may indicate.

A *fixed* expansion is one arranged to cut off at a determinate part of the stroke.

An *automatic* expansion is one which is regulated by the governor, and varies with the amount of power required.

The expansion gear of marine engines generally consists of a graduated *cam* on the paddle-shaft, against which a *roller* presses and communicates the movement peculiar to the irregular surface of the cam, through a series of rods and levers, to the *expansion-valve* situated between the throttle-valve and the slides. See EXPANSION-VALVE.

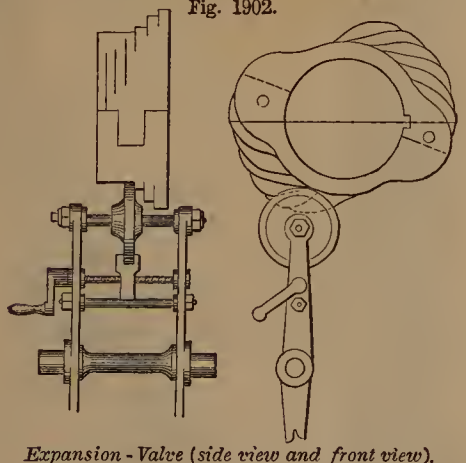
Ex-pan'sion-joint. 1. A stuffing-box joint used when a straight metal pipe, which is exposed to considerable variations of temperature, has no *elbow* or curve in its length to enable it to expand without injury. The end of one portion slips within the other telescopically. Known as a *faucet*-joint.

2. An elastic copper end to an iron pipe to allow it to expand or contract without injury.

3. An attachment of a boiler in its framing to allow the former to expand without affecting the framing.

Ex-pan'sion-valve. A valve arranged to cut off the connection between the boiler and cylinder

Fig. 1902.



Expansion-Valve (side view and front view).

at a certain period of the stroke of the piston, in order that the steam may act expansively during the remainder of the stroke.

One form of this apparatus, for marine engines, derives its motion from the crank-shaft of the engine, the valve-spindle being connected by a series of rods and levers with a small brass pulley which presses against the periphery of a graduated cam on the crank-shaft, by which means the steam is "cut off" in the most advantageous manner at any required portion of the stroke. See CUT-OFF.

Ex'ple-tive-stone. (*Masonry.*) One used for filling a vacuity.

Ex-plor'er. An apparatus by which the bottom of a body of water is examined, when not beyond a certain depth.

In one form it is called a submarine telescope; in other forms it is a diving-bell, submarine-boat, etc. See ARMOR, SUBMARINE; DIVING-BELL; SUBMARINE-BOAT; SUBMARINE-TELESCOPE.

Ex-plo'sive-ball. One having a bursting-charge which is ignited on concussion or by time fuse. See SHELL.

Ex-plo'sives. Gunpowder was in use as far back as the twelfth century, and its composition, as shown by old manuscripts, did not differ greatly from the most approved modern manufacture. See GUNPOWDER.

Berthollet proposed to substitute chlorate of potash for saltpeter in the manufacture of gunpowder. The explosive force was in this way doubled, but it was found to explode too readily, and, at a trial in loading a mortar, at Essonnes, 1788, the powder exploded when struck by the rammer, blowing mortar and gunners to pieces.

Fulminates of gold, silver, and mercury were experimented with in the early part of this century, as substitutes for gunpowder. Fulminate of mercury is obtained by dissolving mercury in nitric acid and adding a certain proportion of alcohol and saltpeter to the mixture. It is used extensively in the manufacture of percussion-caps and cartridges, but none of the fulminates are likely to be used in large quantities, as being too expensive and dangerous. In an experiment at Paris, a grain of fulminate of gold was placed on an anvil and exploded by a blow from a sledge, making a dent in both hammer and anvil.

Pyroxyline, or gun-cotton, was discovered by Schoenbein in 1846. It is prepared by immersing cotton in a mixture of nitric and sulphuric acid for a few minutes, and then washing and drying it. It has been experimented with by several European nations in connection with fire-arms, but was found to be dangerous, and to rapidly destroy the arms by its excessive energy, and was abandoned by all but the Austrians, who utilized the improvements of Baron Lenk in gun-cotton, and have several batteries of artillery adapted to use the improved composition. Abel's English gun-cotton is now used for petards and in mining. Several compounds based on gun-cotton are used in the arts, as in collodion for photography, surgery, etc.

Nitro-glycerine, which is pure glycerine treated with nitric acid, was discovered by the Italian chemist Sobrero in 1847, but was very little used until 1863, when it was utilized by Nobel for blasting. The explosive energy of this compound is given as from four to thirteen times that of rifle powder. By an explosion of a few cans of this material on the wharf at Aspinwall in 1866, a considerable portion of the town was destroyed, shipping at some distance in the harbor much damaged, and a number of lives were lost. An explosion of a storehouse containing some hundreds of pounds of nitro-glycerine took place at Fairport, Ohio, in 1870, accompanied with much loss of life. The shock was felt at Buffalo, 160 miles distant.

Nobel, in 1867, invented a compound called dynamite, which consists of three parts nitro-glycerine and one part of porous earth. Dynamite is supposed to be safe against explosion from concussion or pressure. See DYNAMITE.

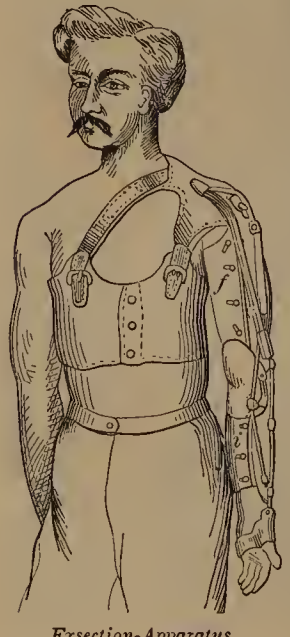
Dualine differs from dynamite in the employment of sawdust with nitro-glycerine, instead of earth or silica. See DUALIN.

Picrate of potash is a yellow salt, extremely explosive, formed from potassium, by the action of picric acid, a product of the distillation of coal-tar. It was experimented with by the French War Department to some extent, and was demonstrated to lie between gunpowder and dynamite in its explosive force.

M. Berthelot gives, in *Annales de Chimie et de Physique*, a table showing the relative force of explosives. From this table is deduced the following, expressed in terms of our own standard measurements: —

	Quantity of heat disengaged by one ounce. Heat units.	Volume of gas formed. Cubic feet.	Relative pressure developed, the pressure of hunting-powder being taken as unity.
Hunting-powder	147,871	0 216	1
Cannon powder	140,215	0 225	0.986
Mining-powder	117,467	0.173	0.633
Mining-powder with excess of niter	155,472	0.111	0.540
Powder with nitrate of soda base.	176,432	0.248	1.368
Powder with chlorate of potash base	224,889	0.318	2.225
Chloride of nitrogen	72,784	0.370	0 842
Nitro-glycerine	306,337	0.710	6.797
Gun-cotton	145,337	0.801	3.636
Gun-cotton mixed with nitrate	228,371	0.484	3.456
Gun-cotton mixed with chlorate	327,528	0.484	4.594
Picric acid	160,309	0.780	3.910
Picric acid mixed with nitrate	223,515	0.408	2.722
Picric acid mixed with chlorate	328,909	0.408	4.198
Picric acid mixed with oxide of lead	49,981	0 120	0.108
Picric acid mixed with oxide of copper	94,204	0.270	0.785
Picric acid mixed with oxide of silver	60,576	0.116	0.208
Picric acid mixed with oxide of mercury	43,762	0 212	0 288
Picrate of potash	135,663	0 585	2.476
Picrate of potash mixed with nitrate	197,161	0.337	2 059
Picrate of potash mixed with chlorate	328,449	0 337	3.574

Fig. 1903.



Exsection-Apparatus.

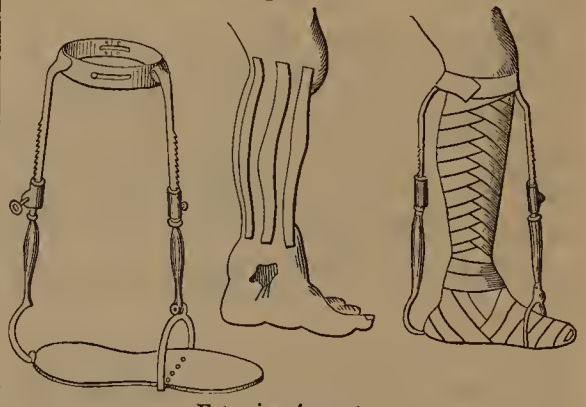
See—
Blasting.
Blasting-powder.
Dynamite.
Fulminate.
Fuse.
Gun-cotton.
Gunpowder.
Lithofracteur.
Nitrine.
Nitro-glycerine.
Nitroleum.
Percussion-powder.

Ex-sec'tion-ap'pa-ra'tus. (*Surgical.*) A splint or support to stiffen and aid an arm from which a section of bone has been removed. In the example, it has a scapula or saddle-pad which forms a foundation for the other parts, and from this proceed jointed rods and elastic bands, which form auxiliary bones and muscles. The humerus and the forearm have rigid cases which afford means of attachment for the prosthetic parts, and the cases are held to the arm by flexible aponeurotic bands *f i*.

Ex-tend'ed-let'ter. (*Printing.*) One having a face broader than usual with a letter of its hight.

Ex-ten'sion-ap'pa-ra'tus. (*Surgical.*) An instrument designed to counteract the natural tendency of the muscles to shorten when a limb has been fractured or dislocated. Ordinarily this is done by means of a weight and pulley attached to an arrangement surrounding the limb immediately

Fig. 1904.



Extension-Apparatus.

above the point of fracture; but in the apparatus shown in Fig. 1904 this is effected by screw-threaded rods, the lower one of which carries a plate applied beneath the sole of the foot and attached by a stirrup passing over the instep. It is obvious that this apparatus may be also adapted to dislocations or fractures of the humerus or forearm. See also COUNTER-EXTENSION.

Fig. 1905.

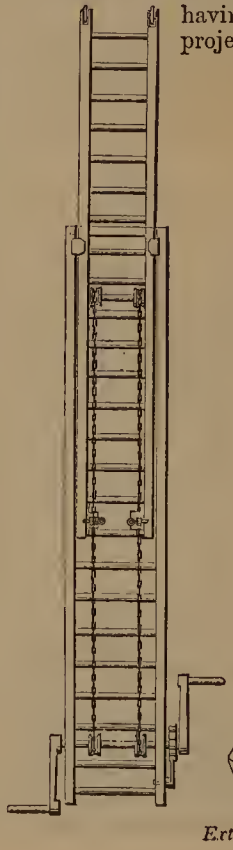


Fig. 1906.

Extension-Ladders

Ex-ten'sion-lad'der. A ladder having a movable section, which is projected in prolongation of the main

section when occasion requires. A common form is shown in Fig. 1905, in which the sections of the ladder slide upon each other, and the upper one is extended by chains which pass around rollers and are wound upon a windlass journaled to the lower section.

Another form has a standing base part. The ladder is formed of jointed sections, which may be folded together or arranged as a self-supporting ladder. Some ladders are mounted on trucks to be used in emergencies. See FIRE-ESCAPE.

Some of the Roman scaling-ladders were made in sections and put together to form a large ladder. Others of their ladders might be elevated with a man on the top for reconnoitering.

Ex-te'ri-or-screw. One cut upon the outside of a stem or mandrel, in contradistinction to one whose thread is cut on an interior or hollow surface.

Ex-te'ri-or-slope. (*Fortification.*) The slope of a parapet towards the country. It is at the foot of the *superior* slope, and forms the lower portion of the rampart above the *escarp*, or the *berme*, if there be one. See PARAPET.

Ex-tin'guish-er. A little cone placed on top of a burning candle to extinguish the light. Extinguishers were also formerly attached to the railings of city houses to enable the link-boys to dout their torches.

Some lamps have attachments which may be made to clasp the exposed portion of the wick and extinguish the flame.

Ex-tract'or. (*Surgical.*) An instrument for removing substances from the body. See BULLET-FORCEPS, etc.

Ex'tra-dos. The exterior curve of an arch, measured on the top of the voussoirs ; as opposed to the *soffit* or *intrados*.

Eye. An opening through an object ; as, —

1. (*Nautical.*) *a.* A circular loop in a shroud or rope. A worked circle or grommet in a hank, rope, or sail.

b. The loop of a block-strap.

c. The hole in the shank of an anchor to receive the ring.

2. (*Milling.*) The hole in a runner stone through which the grain passes to be ground.

3. The hole through the center of a wheel, to be occupied by the axle, axis, or shaft.

4. The eye of a crank ; a hole bored to receive the shaft.

5. A metallic loop on the end of a trace, to go over the pin or hook on the end of a single-tree. A *cock-eye*.

6. (*Architecture.*) *a.* The circular aperture in the top of a dome or cupola.

b. The circle in the center of a volute scroll.

c. A circular or oval window.

7. The hole in the head of an eye-bolt.

8. The center of a target. A bull's-eye.

9. The thread-hole in a needle.

10. The loop in which the hook of a dress catches.

Eye, Ar'ti-fi'cial. 1. A shell or segment of a hollow sphere, usually made of enamel, and so inserted as to present the appearance of the natural eye.

Artificial eyes made of glass are found in ancient Egypt. In the Abbott Museum of Egyptian Antiquities, New York, are several wooden cats with glass eyes. One of them is but a shell, and contains the mummy of a cat. They are from the cat-tombs of Sakkarah.

Fig. 1907.

Artificial Eye.

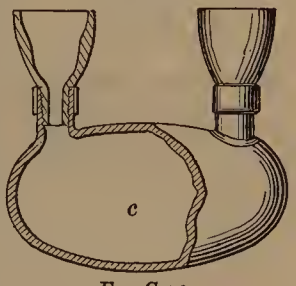
In the example (Fig. 1907), the caruncular portion of the ocular orbit has unguinal depressions on each side of the nasal extremity, so as to establish harmony between the circumference of the prosthetic shell and the organic sinuosities when used on either side.

2. (*Nautical.*) An eye worked into the end of rope, as a substitute for a spliced eye.

Eye-bolt. A bolt having an eye or loop at one end for the reception of a ring, hook, or rope, as may be required. The insertion of a closed ring into the eye converts it into a ring-bolt.

Eye-cup. A cup for washing the eyeball. Its lip is held firmly against the open lid, and the eye-wash dashed against the ball, or forced against it by compressing the reservoir, as in the example. The device shown is also applicable to the eyeball for the purpose of preventing myopia by preserving the convexity of the cornea; the bag *c*, being partially exhausted, is allowed to expand after the edges of the cups are seated upon the eye-balls.

Fig. 1908.



Eye-Cups.

Eye-ex'tir-pa'tor. A surgical instrument for removing the eye.

Putting out the eyes has long been a common Oriental punishment. The eyes of Zedekiah were put out by Nebuchadnezzar. Xenophon states that in the time of the younger Cyrus the practice was so common that the blinded men were a common spectacle on the highways. The Kurds and Turkestan hordes yet blind their aged prisoners.

Eye-glass. 1. (*Optics.*) The glass nearest to the eye of those forming the combination eye-piece of a telescope or microscope. The other *glass*, nearer to the object-glass, is called the *field*-glass. See NEGATIVE EYE-PIECE.

2. A pair of glasses to aid the sight ; usually worn by clasping the bridge of the nose. They are of various shapes, *a b c d*. The watchmaker's or engraver's eye-glass *e* has a horn frame and a single lens. Its flaring edge is retained within the ocular orbit by the muscular contraction of the eyelids.

Fig. 1909.

Eye-Glasses.

Eye-head'ed Bolt. A form of bolt having an eye at the head end. It is intended for securing together two objects at right angles, — as a gland to a stuffing-box, etc. See BOLT.

Eye-in'stru-ments.

Operative.	Ectropium.
Cataract-knife.	Entropium.
Cataract-needle.	Entropium-forceps.
Couching-instrument.	Eye-cup.

Eye-extirpator.
Eye-forceps.
Eyelid-dilator.
Eye-protector.
Eye-speculum.
Eye-syringe.
Iriankistrium.
Iridectomy-instrument.
Keratome.
Lachrymal-duct dilator.
Pterygium.
Strabismus-forceps.
Strabismus-scissors.

Examinative.
Auto-opthalmoscope.
Iridioscope.
Opsiometer.
Ophthalmometer.
Ophthalmoscope.
Ophthalmostate.

Prosthetic.
Eye. Artificial
Pupil. Artificial

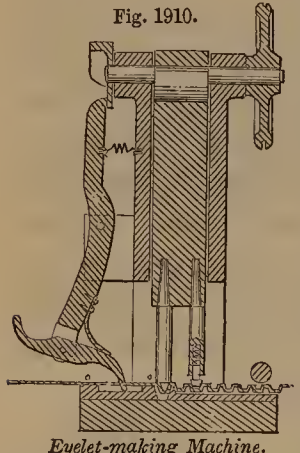
Optical.
Eye-glass.
Goggles.
Shades.
Spectacles.
See OPTICAL INSTRUMENTS.

Eye-lens. That one of the four lenses in an eye-piece which is nearest to the eye. The *eye-piece.*

Eye'let. A short metallic tube whose ends are flanged over against the surfaces of the object in which the said tube is inserted. It is used as a bushing or reïnforce for holes to prevent the tearing of the perforated edge of the fabric or material by the lacing.

Eyelets are made from strips of metal by a cutting and punching operation, or punching and shaping. In the example, the strip of eyelet metal is forwarded by the grasping jaws of a reciprocating lever, between the dies which form frusto-conical recesses, preliminary to annealing and punching.

Fig. 1910.



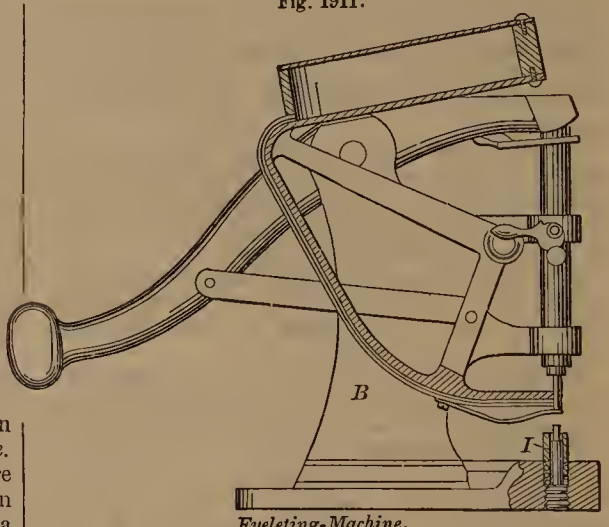
Eyelet-making Machine.

Eye'let-eer'. A stabbing instrument of the work-table, to pierce eyelet-holes. A *stiletto.*

Eye'let-ing-ma-chine'. A machine for attaching eyelets to garments or other objects.

The guide-pin within the punch takes the eyelets from the mouth of the feeding-chute *B*, said pin being subjected to the action of a spring having a tendency to force it out of the punch. When pushed in, the guide-pin is retained by a spring-catch which is automatically released as often as the punch reaches its highest position. The friction-spring retains the eyelets on the guide-pin till the punch forces them off. The anvil *I* has a projecting point, and is surrounded by an elastic tubular bed, so that the material to be eyeleted, on being forced over the point, is pierced and then supported by the elastic bed, which offers sufficient resistance to permit the eyelet to be forced through the hole.

Fig. 1911.



Eyeleting-Machine.

Eye'let-punch. A device used at the desk for attaching papers together by eyeleting. It has usually a hollow punch for making a hole, and a die-punch to upset the flange of the eyelet.

Eye'let-set'ting Ma-chine'. See EYELETING-MACHINE.

Eye-piece. (*Optics.*) An *eye-piece*, or *power*, as it is sometimes called, is the lens or combination of lenses used in microscopes or telescopes to examine the aërial image formed at the focus of the object-glass. — BRANDE.

Eye-pieces may be, —

1. *Positive* (Ramsdens).
2. *Negative* (Huyghenian).
3. *Diagonal.*
4. *Solar* (Dawes).
5. *Terrestrial* or *erecting.*

Eye-piece Mi-crom'e-ter. A graduated slip of glass introduced through slits in the eye-piece tube, so as to occupy the center of the field. Adapted by Jackson.

Eye-rim. A circular single eye-glass, adapted to be held to its place by the contraction of the orbital muscles.

Eye-spec'u-lum. (*Surgical.*) An instrument for dilating the eyelids, to expose the exterior portions of the eye and its adjuncts.

Fig. 1912.

Eye-Speculum.

Eye-splice. (*Nautical.*) A splice made by turning the end of a rope back on itself and splicing the end to the standing part, leaving a loop.

F.

Fab'ric. A cloth made by weaving or felting. The various names are derived from material, texture, fineness, mode of weaving, color, mode of coloring, surface-finishing, place of manufacture, etc.

> "Each glossy cloth, and drape of mantle warm,
> Receives th' impression; ev'ry airy woof,
> Cheyney, and baize, and serge, and alepine,
> Tammy, and crape, and the long countless list
> Of woolen webs."
>
> DYER, *The Fleece*, 1757.

The following list includes the names of the principal varieties of fabrics, except those of merely fanciful and ephemeral nature: —

Abee.
Aditis.
Aërophane.
Agabanee.
Alpaca.
Anabasses.
Anacosta.
Anagaripola.
Angola.
Arbaccio.
Arlienanse.
Armozine.
Armure.
Atlas.
Baetas.
Baft.
Baftas.
Bagging.
Baize.
Balmoral.
Baluster.
Balzarine.
Bandanna.
Bandannois.
Bangra.
Barège.
Barmillians.
Barracan.
Barrage.
Barras.
Barretees.
Batiste.
Barutine.
Bauge.
Beaver.
Beaverteen.
Bengal.
Bengal-stripes.
Bergamot.
Bezan.
Binding-cloth.
Birrus.
Blancard.
Blanket.
Blunk.
Bobbinet.
Bocasine.
Bocking.
Bombazine.
Bonten.
Book-muslin.
Bootee.
Boquin.
Borders.
Borel.
Boshah.
Braid.
Breluche.
Brilliant.
Broadcloth.
Brocade.
Brocatelle.
Buckram.
Buke-muslin.
Bunting.
Burdett.
Burlap.
Cacharado.
Cadence.
Caffa.
Calamanco.
Calico.
Cambayes.
Cambria.
Camlet.
Camptulicon.
Cannequin.
Cangan.
Cantaloon.
Canton flannel.
Cantoon.
Canvas.
Carpet.
Cashmere.
Cashmerette.
Cassimere.
Cassimerette.
Castor.
Cauthee.
Chainwork.
Challis.
Chambray.
Charkana.
Check.
Check-mak.
Chenille.
China-grass cloth.
Chinchilla.
Chiné.
Chintz.
Chitarah.
Cloth.
Coburg-cloth.
Cog-ware.
Collar-check.
Coothay.
Cordillas.
Corduroy.
Cossas.
Cotillion.
Cottonade.
Crape.
Crape-morette.
Crash.
Crepon.
Crequillas.
Crinoline.
Cristale.
Cut-velvet.
Damask.
Damask-satin.
Damassin.
De bege.
De laine.
Demyostage.
Denim.
Diaper.
Diaphane.
Dimity.
Doeskin.
Doily.
Domestic.
Domett.
Dooriahs.
Dorsel.
Dorsour.
Dowlas.
Drab.
Drabbets.
Drap d'été.
Dreadnaught.
Drill.
Drugget.
Ducape.
Duck.
Duffels.
Duroy.
Duttees.
Elastic-goods.
Empress-cloth.
Farandams.
Felted cloth.
Fearnaught.
Fernandina.
Fingroms.
Flannel.
Floor-cloth.
Foulard.
Foundation-muslin.
Frieze.
Fustian.
Gabarage.
Gala.
Galloon.
Gambroon.
Gauze.
Gaze-a-blutoir.
Gimp.
Gingham.
Gobelins.
Golpathen.
Gorgonelle.
Gossamer.
Grass-cloth.
Grenadine.
Grogram.
Gros.
Gunny.
Hair-cloth.
Holland.
Huckaback.
Hum-hum.
India-rubber cloth.
Ingrain.
Jaconet.
Jamdari.
Janus-cloth.
Japanese silk.
Jean.
Jemmy.
Kalmuck.
Kennets.
Keper.
Kersey.
Kerseymere.
Kompow.
Lace (varieties, see LACE).
Lapping.
Lasting.
Lawn.
Leno.
Levantine.
Linen.
Linsey.
List.
Lockram.
Long-cloth.
Loonghie.
Lustring.
Lutestring.
Mail-net.
Marabout.
Marseilles.
Marsella.
Match-cloth.
Matting.
Medley-cloth.
Melton.
Merino.
Milled cloth.
Millinet.
Mixed fabrics.
Mohair.
Moire.
Moleskin.
Moquette.
Moreen.
Mozambique.
Mull-muslin.
Mungo.
Muslin.
Muslin de laine.
Muslinet.
Nacarat.
Nainsook.
Nankeen.
Narrow-cloth.
Neigelli-cloth.
Net.
Nettle-cloth.
Oil-cloth.
Oiled silk.
Oil-skin.
Organdie.
Organzine.
Orleans-cloth.
Osnaburg.
Pack-cloth.

Padesoy.
Palampoor.
Panne.
Paper-muslin.
Paramatta-cloth.
Pennistone.
Percale.
Petersham.
Pile.
Pillow.
Pilot-cloth.
Pique.
Piquée.
Plaid.
Plain-back.
Platilla.
Plonket.
Plumeta.
Plush.
Poldway.
Polemit.
Polimita.
Pongee.
Poplin.
Pou-de-soy.
Poulon.
Poyal.
Princettas.
Print.
Prunello.
Puddie.
Punjum.
Purdah.
Rattanas.
Ratteen.
Ravens-duck.
Razago.
Ribbon.
Romal.
Rubber.
Rubber-cloth.
Rug.
Rugging.
Rumswizzle.
Russia-duck.
Sacking.
Sagathy.
Sail-cloth.
Sarsnet.
Satin.
Satinet.
Satin-jean.
Say.
Sayette.
Seehand.
Selvage.
Sendal.
Serge.
Sergette.
Shag.
Shalli.
Shalloon.
Sheeting.
Shirred goods.
Shirting.
Shoddy.
Shot-silk.
Silesia.
Silk.
Silk-shag.
Sof.
Soocey.
Spinel.
Stripe.
Stuff.
Swansdown.
Swiss-muslin.
Tabaret.
Tabby.
Taffety.
Tambour.
Tammy.
Tape.
Tapestry.
Tarletan.
Tarpaulin.
Tartan.
Terry-fabric.
Thibet-cloth.
Thickset.
Ticking.
Tickenbergh.
Tiffany.
Tinsel.
Tissue.
Tobine.
Toilenet.
Tournay.
Toweling.
Trellis.
Tufted fabric.
Tulle.
Tweed.
Twill.
Unions.
Vadmel.
Velours.
Velvet.
Velvetcen.
Verona-serge.
Vessets.
Vitry.
Wadmal.
Watered goods.
Wincy.
Wire-gauze.
Yasmas.
Yergas.

Fa-çade'. (*Architecture.*) The front or face view of a building.

Face. The front, exposed, principal, dressed, or effective surface of an object. The surface from which others are laid off or tried, and by which they are tested as to angle or proportions.

1. (*Horology.*) The dial of watch, clock, compass-card, or counting-register.

2. (*Architecture.*) *a.* The front or broad side of a building. The *façade.* The front of a wall.

b. The surface of a stone exposed on the face of a wall. The sides are *flanks*, the upper and lower surfaces are *beds.*

c. The front of an arch showing the vertical surfaces of the outside row of voussoirs.

3. (*Fortification.*) One of the parts which form a salient angle, projecting towards the *country.* See BASTION.

4. (*Carpentry.*) *a.* The front of a jamb presented towards the room.

b. The sole of a plane.

5. (*Forging.*) *a.* The working portion of a hammer-head.

b. The flat part of an anvil.

6. (*Ordnance.*) The surface of metal at the muzzle of a gun.

7. (*Steam-engineering.*) *a.* The flat part of a slide-valve on which it moves.

b. The flat portion on a cylinder forming a seat for a valve.

8. (*Gearing.*) That part of the acting surface of a cog which projects beyond the pitch line. The portion within that limit is the flank.

9. (*Grinding.*) That portion of a *lap* or wheel which is employed in grinding, be it the edge or the disk.

10. (*Printing.*) The inked surface of a type. The character of the face for size, style, and proportions gives the name to the type. As to proportions, it may be standard, extended, compressed, heavy, light, etc.

11. The edge of a cutting instrument.

Face-ham'mer. One with a flat face, as distinct from one having pointed or edged *peens.*

Face-guard. A mask with windows for the eyes, adapted to the use of persons exposed to great heat, as in glass-houses, forging heavy works, and in the various metallurgic furnace operations.

Also for workmen exposed to flying particles of metal or stone.

Cohn, an oculist of Breslau, made an estimate of the number of workmen in metal who had been injured by flying pieces, and found that among 1,283 workmen, 90 per cent had suffered to some extent; 40 per cent had been under medical treatment; 59 were permanently injured; 21 had lost one eye. He introduced mica spectacles.

Face-joint. That joint of a voussoir which appears on the face of the arch.

Face-piece. (*Shipbuilding.*) A piece of wood wrought on the forepart of the knee of the head.

Face-plan. (*Architectural drawing.*) The principal or front elevation.

Face-plate. (*Turning.*) A plate screwed on to the spindle of a lathe, and affording a means of attaching the work to be turned; or a place of attachment for a pin which comes against the *dog* or *driver* on the work and imparts rotation to the latter.

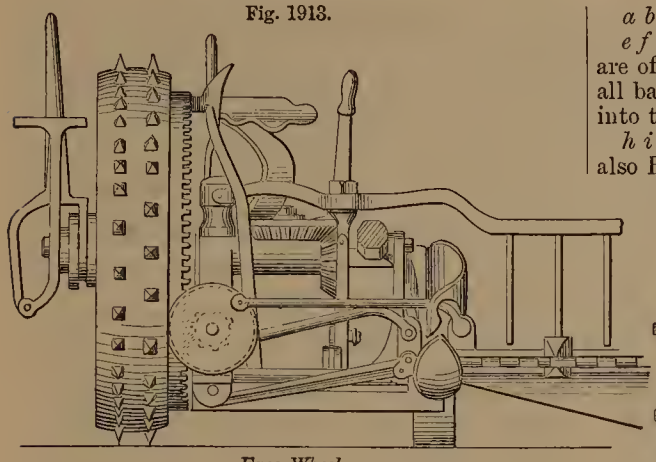
A true plane for testing a dressed surface.

Fac'et. A little face. One of the small planes which form the sides of a natural crystal; of a cut diamond or other gem; of a cut-glass ornament or vessel. The facets of diamonds are known as *skew* or *skill* facets and *star*-facets. *Upper* skill-facets are wrought in the lower part of the *bezel*, and terminate in the *girdle; under* skill-facets are wrought on the *pavilions*, and terminate in the *girdle. Star*-facets are wrought on the bezels and terminate in the table. See BRILLIANT.

Face-wall. (*Building.*) The front wall.

Face-wheel. This is another name for a crown or contrate wheel, which has cogs projecting from the periphery at right angles to the plane of motion. The term is applicable to a wheel whose face rather than its perimeter is made effective, as in the cog-wheels cited and in the annexed illustration, which is the ground-wheel of a harvester. The term is also applied to a wheel whose disk-face is adapted for grinding and polishing. A *lap.*

Fig. 1913.



Face-Wheel.

Fa'ci-a. (*Architecture.*) A flat band projecting slightly from the general surface.

An architrave may have several different faces, termed *facias.*

Fac'ing. An exterior covering or sheathing.

1. (*Hydraulic Engineering.*) *a.* Protection for the exposed faces of sea-walls and embankments. Several different kinds are used, according to the facilities and means.

Earth-work.	Thatch-wood work.
Turfing or sodding.	Wharfing.
Pile and stone work.	Stone-walls.

b. A layer of soil over the *puddle,* upon the sloping sides of a canal.

2. (*Founding.*) Powder applied to the face of a mold which receives the metal.

The object is to give a fine smooth surface to the casting.

The *facing* consists of various materials, economy and the description of casting being taken into consideration.

Meal dust or waste flour.
Powdered chalk.
Ashes of wood or tan.
Charcoal dust.
Loam-stone powder.
Rottenstone powder.

An equivalent effect is produced by depositing a layer of soot upon a metallic pattern by smoking it in a fire of cork shavings, or of resin burned in an iron ladle, or in the flame of a link or a lamp.

3. The front covering of a bank by means of a wall or other structure to enable it to be made steeper than the natural talus of the material.

4. The covering of brick or rough stone-work with fine masonry, such as sawed freestone or marble.

Fac'ing-brick. (*Building.*) Front or pressed brick.

Fag'ot. 1. (*Metal.*) A bundle of scrap or wrought-iron for working over.

It is usually a bunch or pile of bars wedged together in a hoop. If it be large, a round bar in the center is surrounded by the shorter ones and forms a *porter* by which the *fagot* is guided to and from the furnace and underneath the hammer.

Scrap is also *fagoted* for heating in the reverberating furnace, for tilting, or for re-rolling.

In fagoting iron for rolling into beams, respect must be had to the disposition of the pieces, so as to bring the iron of the tread, soffit, and web into the most judicious arrangement for the strain it will be required to bear.

a b c d are fagots for beams.

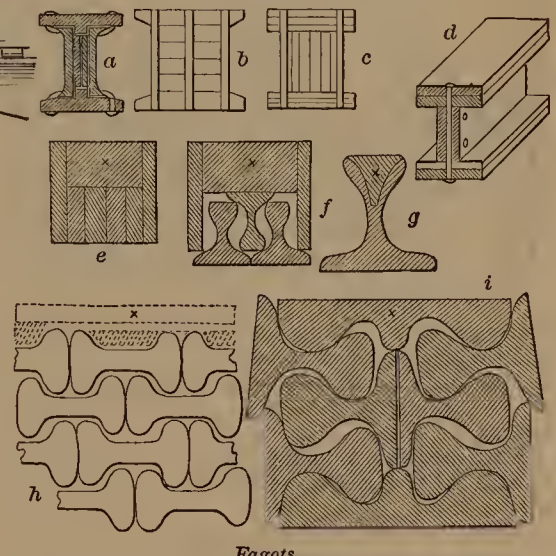
e f are fagots for railway rails in which the portions are of steel, which becomes the tread, as in *g*. *e* is all bar, *f* has a portion of old rails, cut and built into the fagot.

h i are also fagots for beams with steel faces. See also BEAM.

2. A bundle of staves. A *shook.*

3. A bundle of brush-wood. A *fascine.* See also GABION; DIKE; FILLING.

Fig. 1914.



Fagots.

Fag'ot-ed I'ron Fur'nace. (*Metallurgy.*) A form of furnace adapted for scrap and bar cut up and fagoted for reheating and re-rolling.

Fag-ot'to. (*Music.*) An instrument with a reed and mouth-piece like the clarionet, and resembling the bassoon.

Fig. 1915.

Fagotto.

The *alto-fagotto* has a compass of three octaves, commencing with C in the second space, base clef; continuing to the C second ledger line above the treble staff with their intermediate semitones. It has seven keys and key-holes, three on the opposite side to that represented.

Fahr'en-heit. The kind of thermometer used in England and the United States, and named after the inventor. It differs from the Celsius, or centigrade, and the Reaumer. See THERMOMETER.

	Fah.	Centigrade, or Celsius.	Reaumer.
Boiling water .	212°	100°	80°
Freezing . .	32	0	0

Fai'ence. (*Pottery.*) A fine kind of pottery named from Faënza, in Romagna. It was originally made in imitation of majolica, and afterwards acquired some characteristics. Delft afterwards became celebrated for the manufacture of faïence. This ware, having passed through the fire, preserves a certain amount of porosity, and is then covered with a glaze.

The different kinds of faïence are produced by the use of common or of fire clay; the admixture of sand with the clay, as in Persian ware; the use of a transparent or of a colored glaze; of an opaque or

translucent enamel ; and by a combination of these processes on the same piece.

Faints. (*Distilling.*) The later results of distillation of *wash*, of low specific gravity, and reserved for redistillation.

Fair-lead'er. A guide for a rope. It may be a thimble, cringle, or sheave.

Fig. 1916.

Fair-Leader.

A perforated board, through whose respective holes the various ropes of running-rigging are rove to keep them distinct.

Fair-leath'er. (*Leather-manufacture.*) Leather finished in the natural color or that imparted by the tanning process ; free from any special coloring, — black, for instance.

Fake. A winding or coil of a rope or hawser. In the *coil* the *fakes* are a helix, and a range or layer of *fakes* forms a *tier*. When the rope is arranged to run free when let go, as in rocket-lines, it is disposed in parallel bends of one fathom each.

Fal'chion. (*Weapon.*) A sword in use in the 13th century, with a broad blade widening towards the point, the edge convex.

Fal'con. An old-time piece of ordnance, about 7 feet long, having a bore of 3 inches, and throwing a 3-pound ball.

Fal'co-net. An old piece of ordnance, smaller than a falcon, throwing a ball of 1½ pounds weight.

Fald-stool. A folding stool, or backless seat. It is as old as Rameses, and is now commonly called a *camp-stool*. *Faldistory*.

Fall. 1. That part of the rope in hoisting-tackle to which power is applied. One end of the rope is attached to a point of support, say a hook or an eye below the upper block of the tackle, and is then rove through the blocks ; the end carried to the *winch*, *capstan*, *crab*, or other hoisting-engine, is the *fall*.

2. The amount of descent in a given distance ; as, —

a. The vertical pitch of water at a mill.

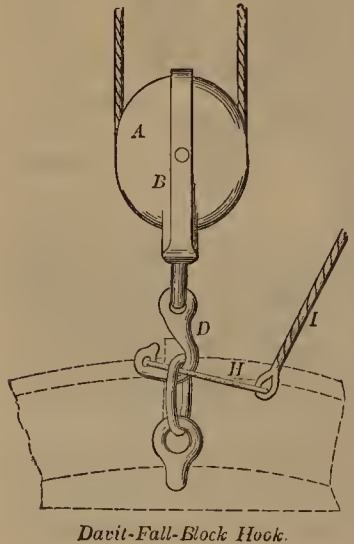
b. The inclination of a water-course.

Large and deep rivers run swiftly with a fall of 1 foot per mile, or 1 in 5,000.

Smaller rivers and branches require double the fall, or 2 feet per mile, 1 in 2,500.

Small brooks hardly keep an open course under 4 feet per mile, or 1 in 1,200.

Fig. 1917.



Davit-Fall-Block Hook.

Ditches and covered drains require 8 feet per mile, or 1 in 600.

Furrows of ridges and open drains require a still greater fall.

Fall and Tack'le. The fall is the pulling-end of the rope ; the tackle is the blocks with the rope rove through them. See Block ; Tackle ; Purchase.

Fall-block Hook. A hook *D* for a davit-fall block *A B* released by the action of the cord *I* and link *H*, when the boat has descended a certain distance, the end of the rope *I* being secured on deck. There are other forms. See Davit.

Fall'er. 1. (*Cotton-manufacture.*) The *faller* is an arm on a *mule-carriage*, operating the *faller-wire*, whose duty it is to depress the yarns when the carriage is about to run back, in order that the yarns may begin to wind on at the bottom of the *cop* and be regularly distributed thereon as the faller-wire is raised. See Mule. The *counterfaller* is another wire beneath the yarns, and counterweighted to keep them taut.

2. (*Flax-manufacture.*) A bar in the flax-spreading machine, having attached a number of vertical needles, forming a comb or *gills*. A *gill-bar*. The office of the *gills* is to simulate the action of the human fingers in detaining to some extent the *line* as it passes to the drawing-roller. See Spreader.

The term *faller* is derived from the motion, the *gill* being raised and lowered so as to alternately detain and release the *line*.

Fall'er-wire. 1. A horizontal bar by which the rovings, slubbings, or yarn are depressed below the points of the inclined spindles in a *slubbing-machine* or *mule*, in order that they may be wound into *cops* upon the spindle in the backward motion of the *billy*, or *mule*-carriage, as the case may be. See Slubbing-machine ; Mule.

2. A device in the silk-doubling machine for stopping the motion of the bobbin if the thread break. The wire is hung by its eyelet end to the thread, and with the breakage of the latter falls upon the lighter arms of a balance-lever and actuates a detent.

False. A term used as to constructions, or parts of a temporary or supplemental character.

False-core. (*Founding.*) A part of a pattern which is used in the *undercut* part of a mold, and is not withdrawn with the main part of the pattern, but removed by a lateral draft subsequently.

False-keel. (*Shipbuilding.*) Timbers worked on to the main or true keel, and intended, —

1. To prevent leeway.

2. To protect the main keel in case of grounding.

False-keel'son. (*Shipbuilding.*) One lying longitudinally above the real one.

False-key. A key roughly made of a bent slip adapted to avoid the wards of a lock. A *pick-lock*.

False-pile. (*Pile-driving.*) An additional length given to a pile after driving. A temporary prolongation at the upper end, when the pile has passed beyond the immediate reach of the monkey, is called a *sett*.

False-rail. 1. (*Carpentry.*) A thin piece of timber inside of a curved head-rail.

2. (*Shipbuilding.*) A facing or strengthening rail fayed to a main rail.

False-roof. (*Carpentry.*) The part between the ceiling of the upper chambers and the roof-covering.

False-stem. (*Shipbuilding.*) One fayed to the forward part of the stem.

False-stern. (*Shipbuilding.*) *False stern-post*, etc. Supplemental structures or timbers accessory to the main parts or pieces.

False-works. (*Civil Engineering.*) Construction works to enable the erection of the main works. Among *false-works* may be cited coffer-dams, bridge-centering, scaffolding, etc.

Fan. 1. A device waved or rotated to cause a circulation of air.

The *chowry*, or fly-flapper of the plains of India, is made of the bushy tail of the Thibetan yak.

Fans made of ostrich and other feathers were commonly used in Egypt, for the purpose of setting the

air in motion, and also for brushing away flies. The honor of attending the king in the capacity of fan-bearer was conferred upon his sons, and we see them in many Egyptian paintings and sculptures, with the insignia of princes and carrying the flabella, a wing or bunch of feathers on the end of a long handle. Among other paintings may be specially cited that of the triumph of Rameses III., the great Sesostris of Herodotus, about 1355 B. C. The flabellum is shown in the tombs of Beni-Hassan, Thebes, and Alabastron, of dates from 1706 to 1355 B. C. In more humble life, men are represented keeping the flies away from the drink prepared for the reapers in the field. See BELLOWS; BLOWER; PUNKAH; VENTILATOR; and list under AIR-APPLIANCES.

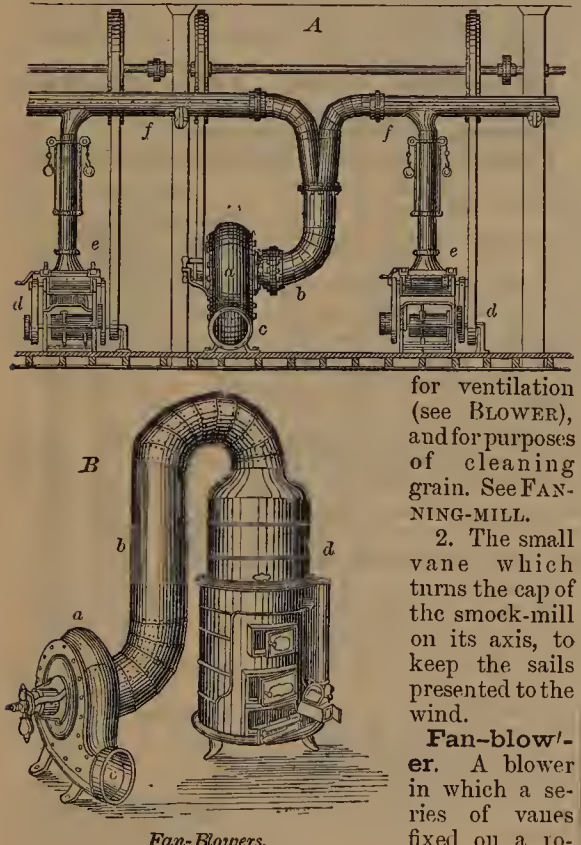
"Cape hoc flabellum, et ventulum huic sic facito," — Take this fan, and give her thus a little air.

Fans made of ostrich and other feathers maintained their hold upon the people, and were common in the reign of Elizabeth, being ornamented with gold and silver. According to Evelyn, our modern paper fans were introduced by the Jesuits from China.

The common palm-leaf fan of this country is imported from the East and West Indies, and is made of a portion of the leaf and stalk; the leaf being bound on the edges with strips and thread. The Japanese fan is made of bamboo and paper. A stalk of bamboo forms the handle, is split into a number of fibers which are displayed in fan shape and fastened in position while paper is applied on each side. They are then painted and inscribed with scenes rural and humorous, and have mottoes which do not convey any very distinct impression to us as a people.

Mechanical fans for household uses are driven by clock-work or weight, are rotary or oscillating. On a larger scale, they are used for urging fires and for ventilation (see BLOWER), and for purposes of cleaning grain. See FANNING-MILL.

Fig. 1918.



Fan-Blowers.

2. The small vane which turns the cap of the smock-mill on its axis, to keep the sails presented to the wind.

Fan-blow'er. A blower in which a series of vanes fixed on a rotating shaft creates a blast of air for forge purposes, or a current for draft or ventilation. In the example (*A*, Fig. 1918), the machine is applied to removing shavings from the cutters of planing-machines. The rotation of the fan, by belt and pulley, in its box *a*, causes a downward draft through the pipe *b*, connected with which are the horizontal pipes *f f* and vertically adjustable pipes *c c*, having flaring mouths directly over the cutters *d* of the planers; the shavings are drawn upward through the pipes *e*, and carried through *f b*, when, passing through the blower, they are driven through its mouth *c* into a chute which takes them to an apartment whence they may be removed as required for fuel.

B (Fig. 1918) is intended for intensifying the draft of a furnace *d*; the products of combustion, being caused to take first an ascending and then a descending course through the curved pipe *b*, are expelled at *c*. Blowers are *plenum* (pressure), or *vacuum*, which is equivalent to exhaust; either form is used for the various purposes of ventilation, air-draft for furnaces, etc. See also BLOWER; FANNING-MILL.

Fan'cy-line. (*Nautical.*) A down-haul line passing through a block at the jaws of a gaff.

Fan'cy-roll'er. (*Carding-machine.*) One placed immediately in advance of the *doffer*, and provided usually with straight wire teeth, its function being to loosen up the wool on the main cylinder so that it may be taken up with facility by the *doffer*.

Fan'don. A large copper vessel in which the "hot process" of amalgamation is conducted, blocks of copper being drawn around like the porphyry blocks in an arrastra.

Fane. A weathercock. A *vane*.

Fang. 1. (*Mining.*) *a*. A niche cut in the side of an adit or shaft to serve as an air-course.

b. An air-pipe of wood in a shaft. An air-main.

2. A projecting tooth or prong in a lock, bolt, or tumbler.

3. (*Nautical.*) *a*. The valve of a pump-box.

b. The bend of a rope.

4. A long nail.

5. A projecting claw, as that on the reverse of a belt plate, which passes through the belt and is clenched or riveted at the rear.

6. The tang of a tool.

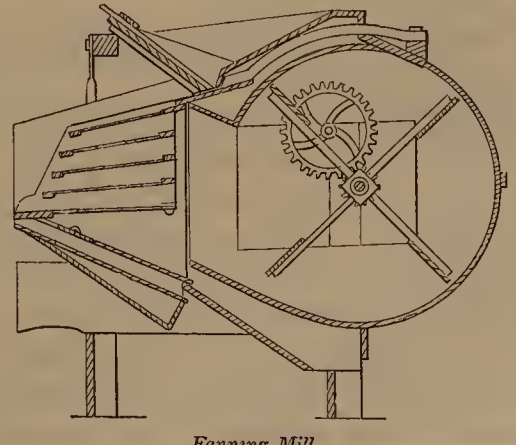
Fan'ion. (Ital. *gonfalone*, a standard.) A small flag for a surveying-station.

Fan-light. (*Architecture.*) A semicircular transom window.

Fan'ner. A blower or ventilating-fan. See FANNING-MILL; BLOWER.

Fan'ning-mill. A machine for cleaning chaff from grain by a blast of air.

Fig. 1919.



Fanning-Mill.

The fans mentioned in the Bible were used for winnowing or cleaning grain. A floor of beaten earth was prepared in a situation exposed to the wind, and the grain and chaff were thrown up by a shovel. The fan was for raising an artificial blast, and was evidently a hand implement. "His fan is in his hand" (Matt. iii. 12). Winnowed with the shovel and the fan (Isaiah xxx. 24). The machine in its simplest form is a rotary shaft with flapping breadths of canvas suspended from the arms.

Fig. 1919 represents the ordinary fanning-mill, having rotating arms with vanes to produce blast, a hopper for the grain, and a series of sieves of varying fineness for sorting the grain into qualities and keeping it longer exposed to the blast. The fanning-mill forms part of the THRASHER and SEPARATOR (which see) and of the clover-huller. Sir Walter Scott relates, in one of his novels, that the religious feeling of some of his countrymen was greatly shocked at an invention by which artificial whirlwinds were produced in calm weather, when it was the will of God for the air to remain still. As they considered it a moral duty to wait patiently for a natural wind to separate the chaff from their wheat, they looked upon the use of the machine as rebellion against God.

Fan'ning-out. Spreading out the sheets of a pile of paper by grasping a corner and giving a dexterous twist. It is to facilitate counting.

Fan Steam-en'gine. The action of this steam is the inverse of that of the fan. The outer annular casing receives steam from the boiler and discharges from its inner surface in tangential jets upon the scoop-shaped blades which are attached to a rotating shaft.

It is one form of the rotary steam-engine, and may be compared to the inward-flow turbine.

The outward-flow turbine has also its congener in a form of rotary steam-engine, in which the steam passes through a central pipe and out at the periphery, impinging by direct pressure upon the curved buckets.

Numerous are the resemblances between this type of rotary steam-engines and the reaction water-wheels or turbines. The constructive features of the Æolipile of Hero and the Barker water-wheel are identical, and the family features are still visible in the rotary steam-engines, rotary-pumps, and water-wheels. This is not extraordinary, when it is considered that the impact or direct pressure of a fluid is in each case exerted upon a body which, by its construction and relation, is confined to move in a curved path, conferring a rotary motion upon the axle to which it is attached.

Fan-tail. 1. A form of gas-burner in which the burning jet has an arched form.

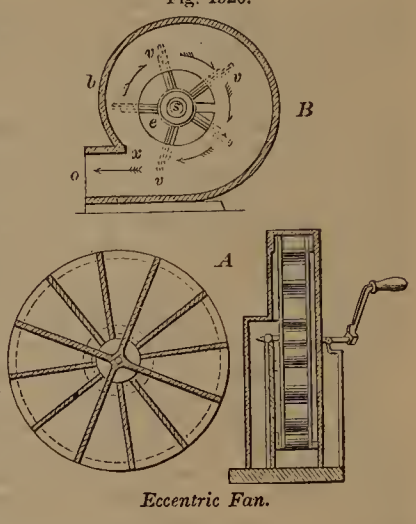
2. A kind of joint.

Fan-vault'ing. (*Architecture.*) A form of arching in which the ribs of the arch diverge from the impost like the sticks of a fan.

Fan-ven'ti-la'tor. The oldest known form of this device is the corps of worker bees arranged on each side of the entrance hole, a little within the hive, engaged in incessantly vibrating their wings so as to cause a circulation of air into, through, and out of the hive. An ingoing and outgoing current is established at the hole, as has been proved by holding filaments of cotton at the aperture.

The *fan* as a mechanical ventilator appears to have been invented by Dr. Desagulier, 1734. His fan (*A*, Fig. 1920) was a wheel 7 feet in diameter, 1 foot wide, and had 12 vanes which approached within 12 inches of the axis, around which was an opening 18 inches in diameter. The vanes rotated as near as possible to the case, which was lined with blanket as a packing. The case was concentric, and had an eduction and an eduction pipe, the one axial, the other peripheral.

Fig. 1920.



Eccentric Fan.

Such a wheel was used above the ceiling of the British House of Commons from 1736 to 1817.

Dr. Desagulier's fan was concentric with its case, but an improvement was to make it eccentric.

Fairbairn and Lillie's eccentric fan is shown at *B*; *s* is the shaft, *b* the case, *v* the vanes, *e* the eduction opening, *o* the discharge. The point *x* is a shoulder which acts as a cut-off in connection with each passing vane, and confines the stream of condensed air to the eduction passage. See also VENTILATOR.

Fan-wheel. This usually consists of an armed shaft with wings or beaters, and revolves in a case. It is used in grain-cleaners, winnowing-machines, blowers for furnaces, etc., and is the most common device for obtaining a blast of air for any purpose. The air is drawn in at the central opening and discharged at the tangential chute. Where great force is required positive devices are used, partaking of the nature of pumps. The volute-wheel is also used for a similar purpose. See FANNING-MILL; BLOWER; BLOWING-APPARATUS.

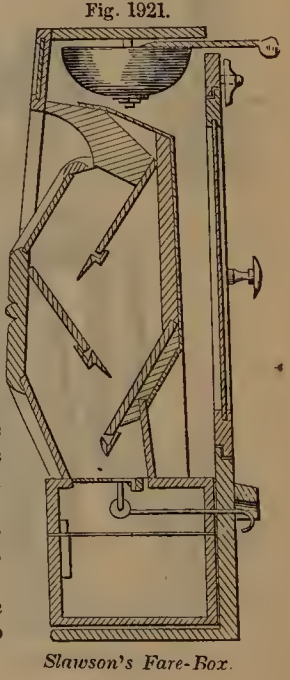
Fan-win'dow. (*Architecture.*) A semicircular window with radial sash.

Far'an-dams. (*Fabric.*) A mixed fabric of silk and wool.

Far'cost. A Scotch trading-vessel.

Fare-box. A place of deposit for fares in street-cars. It has a receiving aperture, windows at which the money or ticket may be seen by the passenger inside and the driver outside the car; a series of slanting plates, which allow the money to drop, but prevent its abstraction; a plate on which the fare falls, and which is tilted to discharge it into a locked box beneath.

Fig. 1921.



Slawson's Fare-Box.

Fas'cet. (*Glass.*) An iron-wire basket on the end of a rod, to carry the bottle from the blowing-rod or the mold to the *leer*.

A rod inserted into the mouth of the bottle for the same purpose is also called a *fascet*.

Fas'ci-a. A flat architectural member in an entablature. A broad fillet.

The architraves of some orders are divided into *fascias*.

Fas-cine'. A cylindrical bundle or fagot of brush-wood used in revetments of earthworks. They vary in size, say from 6 to 18 feet in length, 6 to 9 inches in diameter, and are bound with withes every 18 inches. When the limbs are stouter and longer than usual, it is called a *saucisse* or *saucisson*.

A *gabion* is a basket for earth; not a bundle of brush.

In civil engineering, *fascines* and *gabions* are used in making sea and river walls to protect shores subject to washing; or to collect sand, silt, and mud to raise the bottom and gradually form an island, either as a breakwater or for cultivation, as in Holland.

Fash'ion-ing-nee-dle. (*Knitting-machine.*) One of the pins or fingers employed to take loops from certain of the bearded needles and transfer them to others for widening or narrowing the work.

Fash'ion-piece. (*Shipbuilding.*) One of the pair of cant frames which form the exterior angle of the stern-framing; between them extends the *wing-transom*, which is the base-piece of the *counter-timbers*.

Fast. (*Nautical.*) A mooring rope or hawser, securing a vessel, and named from its position; as, *head*, *bow*, *breast*, *quarter*, or *stern* fasts, as the case may be.

Fast-and-loose Pul'leys. (*Machinery.*) A device for disengaging and re-engaging machinery. One pulley is fast to the shaft, the other runs loosely thereupon. The band is turned on to either, as the work requires.

Fas-tig'i-um. 1. The pediment of a portico.

2. The comb or ridge of a roof.

Fast-pul'ley. (*Machinery.*) One keyed to the shaft so as to revolve therewith. In contradistinction to the *loose-pulley*, which is *loose* on the shaft, and to which the belt is transferred when the rotation of the shaft is no longer desired.

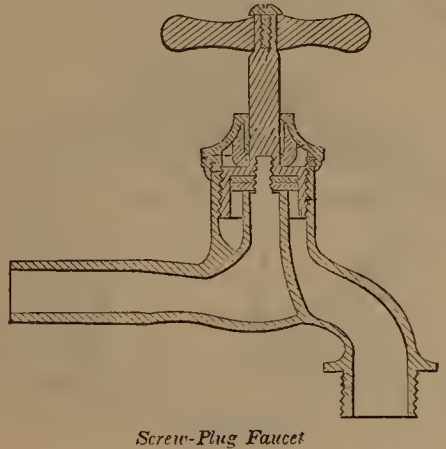
Fat. (*Printing.*) Copy which affords light work, as blank or short pages or lines, leaded matter, rule-and-figure work, poetry, and such like matter profitable to the compositor.

Fa-tigue'. The fracture of a bar owing to the repeated application and removal of a load which is considerably below the breaking weight of the bar. To *fatigue* is ascribed the breaking of car-axles by the constant repetitive blows and strains incident to their duty.

Fat-lute. A mixture of pipe-clay and linseed oil for filling joints.

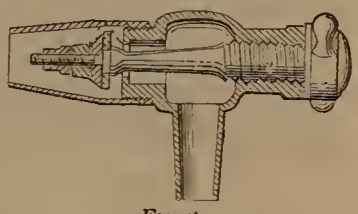
Fau'cet. 1. A form of valve or cock in which a spigot or plug is made to open or close an aperture in a portion which forms a spout or pipe for the discharge or passage of a fluid. The ordinary beer-cock is well known. Fig. 1922 shows a less usual form, in which the central aperture is closed by an elastic packing at the foot of a screw-plug, and opened by the raising of the latter. Fig. 1923 is a modified form having some similar features.

Fig. 1922.



Screw-Plug Faucet

Fig. 1923.



Faucet.

2. The enlarged end of a pipe to receive the spigot-end of the next section.

See under the following heads: —

Auger-faucet.	Gage-faucet.
Ball-cock.	Grease-faucet.
Basin-faucet.	Hot-water faucet.
Beer-faucet.	Measuring-faucet.
Bib.	Molasses-gate faucet.
Blow-off cock.	Pet-cock.
Boring-faucet.	Pit-cock.
Bottle-faucet.	Robinet.
Cork-faucet.	Rotary valve.
Diaphragm-faucet.	Spring-faucet.
Filter-faucet.	Stop-cock.
Four-way cock.	Three-way cock.

Fau'cet-bit. A cutting lip and router on the end of a faucet. The faucet is rotated to cut the hole in the head of the cask, and then the barrel of the faucet immediately occupies the aperture so made. *A boring-faucet.*

Fau'cet-fil'ter. One having a chamber for filtering-material.

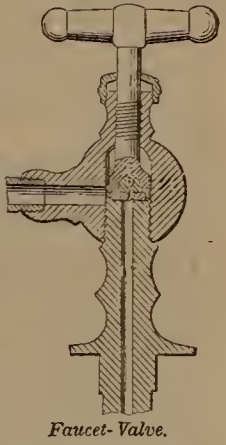
Fau'cet-joint. 1. An expansion-joint for uniting two parts of a straight metallic pipe, which is exposed to great variations of temperature.

2. One form of breech-loader in which the rear of the bore is exposed by the turning of a perforated plug. See FIRE-ARM; *Class B, Div. 5.*

Fau'cet-key. One fitting upon a concealed square projection on the plug of a faucet.

Fau'cet-valve. One in which the puppet or plug-valve is operated by a handle of the faucet order.

Fig. 1924.



Faucet-Valve.

Fauld. The *tymp-arch* or working arch of a furnace.

Fault. (*Mining Engineering.*) The dislocation of a stratum or seam by which the continuity is destroyed and one portion becomes relatively lower than the other. Known also as *shift*, *slip*.

Fausse'braye. (*Fortification.*) A low rampart or counter-guard to protect the lower part of the main escarp.

Fau-teuil'. An easy, upholstered arm-chair.

Fay. A shipwright's term for fitting one piece of timber or plank to another.

Joining two pieces so as to make a flush surface.

Fay'ing-sur'face. That surface of a plate or angle-iron which is to be against the object to which it is to be riveted. The *faying-surface* of the *side-arm* of the angle-iron of a ship's side, and the inside or *faying-surface* of the plate, are in contact.

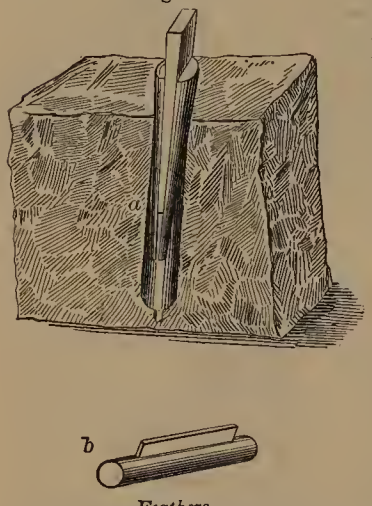
Fear'naught. (*Fabric.*) A heavy, shaggy, woolen fabric, used for seamen's coats, for lining port-holes and the doors of powder-magazines. *Dreadnaught.*

Feath'er. 1. A slip (*b*) inserted longitudinally into a shaft or arbor, and projecting as a fin therefrom so as to fit a groove in the eye of a wheel which may have a longitudinal motion on the said shaft, but no rotation. A *spline*.

2. A wedge-shaped key between two semi-cylindrical plugs (*a*) placed in a bored hole in a stone, and driven in to rend the stone.

3. A tongue on the edge of a board.

Fig. 1925.



Feathers.

4. The angular adjustment of a propeller blade or of an oar in rising from the water.

5. A narrow strengthening strip on a structure. A longitudinal rib on a shafting to resist flexion or fracture.

6. The plumage of birds, as well as the tail and wing feathers, are used for certain purposes after undergoing cleansing and bleaching processes.

Ostrich feathers are procured from Africa, those plucked from live or recently killed birds being the best.

The feathers are tied together in bundles; rubbed in tepid water and soap to free them from grease; washed in pure hot water; dipped in a heated solution of Spanish white; washed; steeped in water tinted with indigo, to correct the yellow color; sulphured; dried.

The ribs are rubbed to render them pliant, and the vanes curled by pressure with a blunt knife.

They are dyed rose-color by safflower and lemon-juice; red by Brazil wood followed by cudbear; blue by indigo; yellow by turmeric; alum is the usual mordant.

The beautiful aniline colors are fast superseding the others for superior work.

Feath'er-edged. Said of boards. One edge is thinner than the other. Used for weather-boarding.

Feath'er-edge File. A file with an acute edge; the cross-section of the file being an isosceles triangle with a short base. A *knife*-file.

Feath'er-ing-float. The paddle or float-board of a paddle-wheel, so arranged as to turn on an axis to present its broad side to the water at its lowest submergence, but to turn its edge to the water in entering and emerging.

Feath'er-ing Pad'dle-wheel. A wheel whose floats have a motion on an axis, so as to descend nearly vertically into the water and ascend the same way, avoiding beating on the water in the descent and lifting water in the ascent. The loss of power from these causes is not as great as is commonly supposed. Some floats are made to feather on axes parallel to that of the wheel, others on axes radial thereto. There are numerous plans.

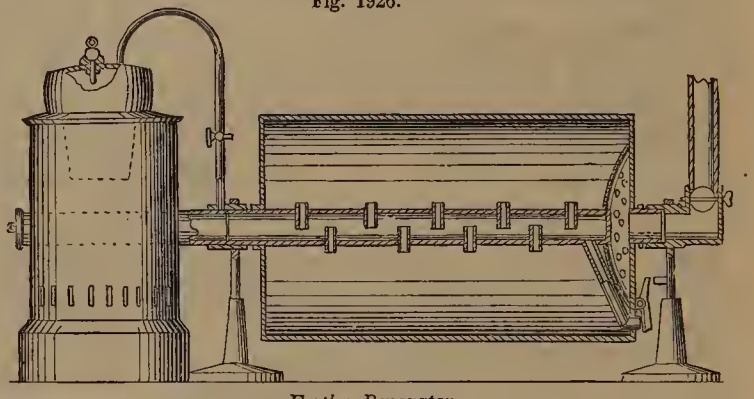
Feath'er-ing-pro-pel'ler. An invention of Maudslay, London, in which the vanes of the propeller-screw are adjustable, so as even to be turned into the plane of the propeller-shaft and offer no resistance when the vessel is under sail and the propeller not used.

Feath'er-ing-screw. See FEATHERING-PROPELLER.

Feath'er-joint. A mode of joining the edges of boards by a fin or feather let into opposite mortises on the edges of the boards.

Feath'er-ren'o-va'tor. A machine in which old feathers may be scalded, purified, and dried, so as to remove effete matter from them. One example among many may be given. Warm or cold air is forced from a chimney through conducting passages in such connection with a boiler and steam-pipes that the air may be moistened more or less with steam as required. Hollow bearings for the renovating cylinder serve as couplings between the central pipe and the draft pipe.

Fig. 1926.



Feather-Renovator.

Feath'er-spring. (*Gun-making.*) The *sear-spring* of a gun-lock.

Feed. 1. The motion or action which carries stuff forward to the machine; as, —

The cloth to the needle in a sewing-machine.

The board to the planer, etc.

2. The motion of a tool towards its work; as, —

The auger, bit, or drill into the object.

The cutter on the slide-rest of a lathe to or parallel to the work suspended on the centers, etc.

3. The supply of material to a machine; as, —

The water to a steam-boiler.

The grain to a run of stones.

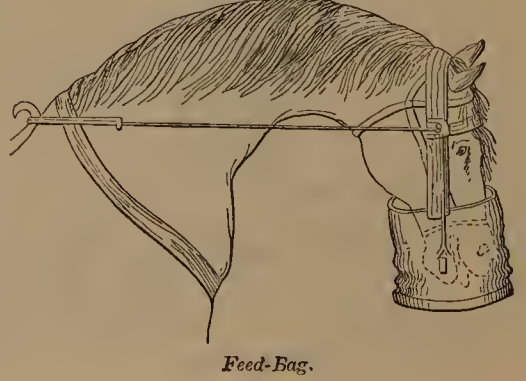
Blanks to a coining-press, or punching-machine.

Eyelets or planchets to the appropriate machines.

Wool or cotton to a carding-machine, etc.

Feed-bag. A nose-bag for a horse or mule, to contain his noon-day feed or luncheon.

Fig. 1927.



Feed-Bag.

Feed-cloth. (*Fiber.*) The apron which leads the cotton, wool, or other fiber into the cleaning, lapping, carding, spinning, or other machine.

Feed-cut'ter. A machine for cutting straw, hay, or cornstalks into short feed or chaff. See STRAW-CUTTER.

Feed'er. An auxiliary or a supplying part of a machine, that which leads along the stuff being operated upon.

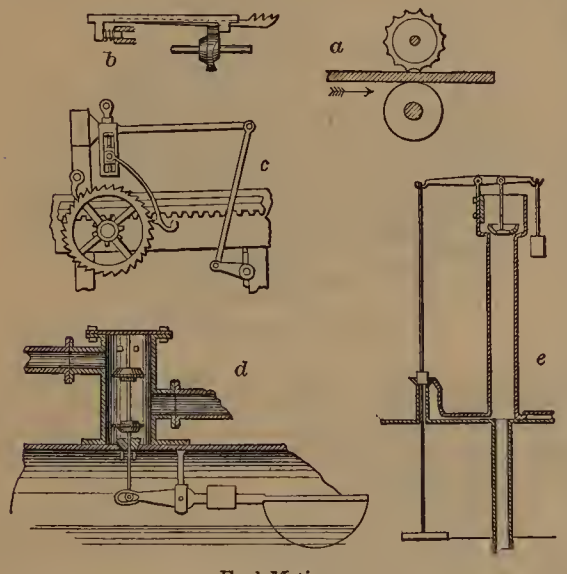
1. (*Hydraulic Engineering.*) A water-course, natural or artificial, carrying water to a canal or reservoir. Obviously, the principal feeder is at the summit level, and it is commonly supplied from a reservoir.

2. (*Mining.*) The side branch of a vein which passes into a lode.

3. (*Sewing-machine.*) That part (*b*, Fig. 1928) which carries the cloth along the length of a stitch between each penetration of the needle. See SEWING-MACHINE FEED. The illustration shows the Wilson four-motion feed.

4. (*Machinery.*) *a.* A toothed or binding wheel which carries the plank into the planing-machine (*a*, Fig. 1928); or a feed for gate-saws (*c*, Fig.

Fig. 1928.



Feed-Motions.

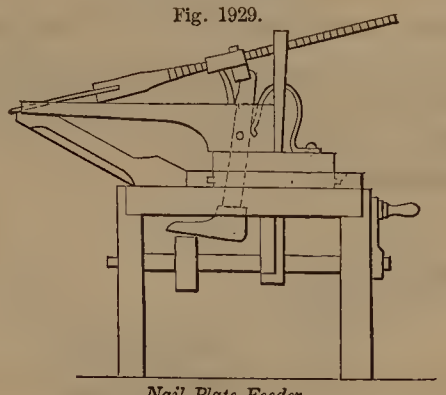
1928), in which a reciprocating arm is provided with a dog to engage the rim of a wheel on the axis of the roller beneath the log-carriage, and so advance the log to the saw a graduated amount at each rise of the saw-gate. An apron of a blowing, cotton-cleaning, lapping, or carding-machine, etc.

b. That motion or combination of parts which carries and directs a blank or rod to the place where it is operated upon. Such are the feeders and feed-motions in machines for making wood screws, pins, eyelets, hooks and eyes, etc. Such also are the motions by which planchets are fed to the coining-press; eyelets and clasps to the machines for attaching them to garments; pins, needles, and hooks and eyes to the machines which stick and paper them.

5. The nail-plate feeder has an intermittent oscillating or semi-rotary and forward motion to present the plate to the cutters so that the head of the nail may be taken from the respective edges alternately.

6. The grain-feeder which forwards the opened sheaves into the throat of the thrasher; or the grain into the eye of the millstone; or the grain and

Fig. 1929.

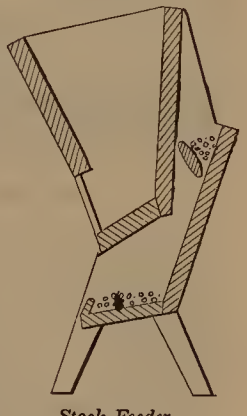


Nail-Plate Feeder.

chaff from the hopper to the riddle of a winnowing-machine; or the grain from the bin to the manger of sheep or other stock. See Fig. 1930.

7. (*Printing, etc.*) A device with fingers which take the top sheet from a pile and lead it into the press where it is printed, folded, or what not. Also a device by which blanks are taken successively from a pile and carried into an envelope-machine, or paper-bag or box machine, as the case may be.

Fig. 1930.



Stock-Feeder.

Some printing-presses and envelope-machines have an aspirator or pneumatic contrivance by which the upper sheet of the pile is picked off and led into the machine. Comly's patent, 1853. See also ENVELOPE-MACHINE. See "Ringwalt's Dictionary of Printing," Philadelphia, 1871, pp. 224, 225.

The usual mode of feeding blanks for envelopes from the pile to the folders is by a plunger with a gummed surface; this descends upon the blank and moves away to the folding-apparatus, where it leaves the blank ready gummed on the end and bottom flaps.

8. A device for supplying steam-boilers with water in graduated quantities, or as occasion may require.

Automatic boiler-feeders act by means of floats upon the surface of the water in the boilers.

One of the illustrations (*d*, Fig. 1928) shows a floating ball on a lever to whose other end is a valve-rod which is lifted when the ball descends below its normal height; floating on the water at the proper level.

The other form (*e*, Fig. 1928) is only intended for supplying water from cisterns at a considerable elevation.

Feed-hand. (*Gearing.*) A rod by which intermittent rotation is imparted to a ratchet-wheel.

Feed-head. 1. (*Steam.*) A cistern containing water and communicating with the boiler of a steam-engine by a pipe, to supply the boiler by the gravity of the water, the hight being made sufficient to overcome the pressure within the boiler.

2. (*Founding.*) Also called *dead-head*, or simply *head*. The metal above and exterior to the mold which flows into the latter as the casting contracts, and also serves to render the casting more compact by its pressure. Also called a *riser*, and the metal which occupies it a *sullage-piece*.

Feed-heat'er. 1. A drum or chamber in which

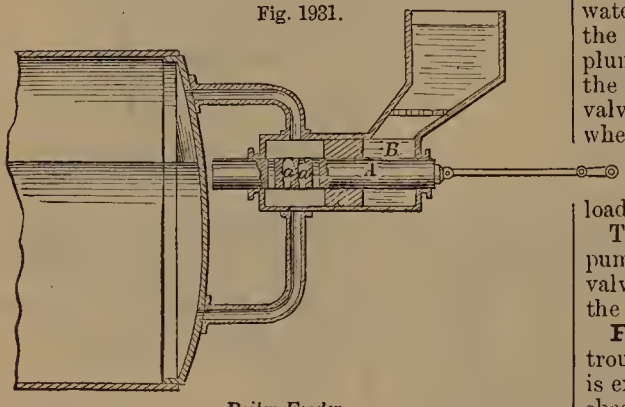
feed-water for the boiler is heated by the exhaust steam.

2. A boiler or kettle for heating food for stock.

Feed'ing-en'gine. (*Steam.*) A supplementary engine for *feeding* the boiler, when the main engine is stopped. A *doctor*.

Feed'ing-head. (*Founding.*) An opening in a

Fig. 1931.

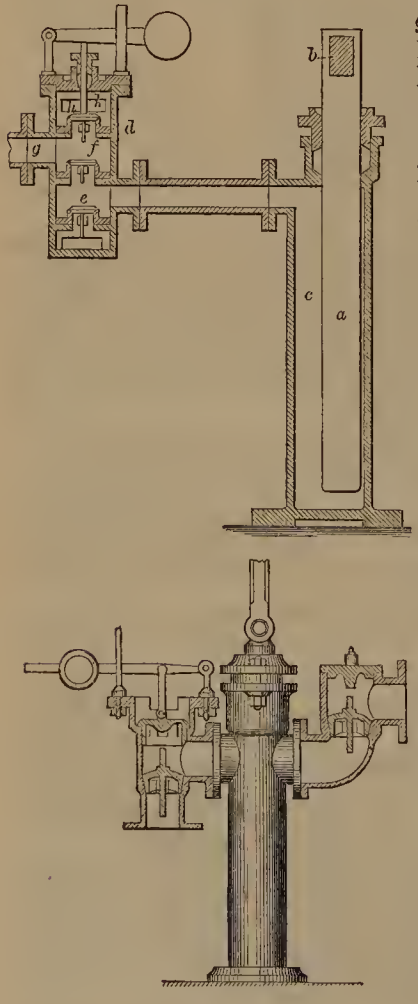


Boiler-Feeder.

mold up which the metal rises, and which supplies metal as the casting contracts.

Feed-mo'tion. That contrivance in a machine by which the material under treatment is advanced. See FEED.

Fig. 1932.



Feed-Pump of Marine Engine.

Feed-pipe. (*Steam-engine.*) The pipe carrying water to the boiler. See FEED.

Feed-pump. A force-pump driven by hand, by doctor-engine, or by the engine itself, for supplying to the boiler a quantity of water equal to that removed in the form of steam, by the brine-pump, the blow-off or mud valve, or other sources of outlet.

In high-pressure engines it takes water from the heater; in condensing engines from the hot-well.

In locomotives it usually takes the form of the Giffard injector. (See INJECTOR.) In the example (Fig. 1931) a plug *A* with cross cells *a a* is constantly reciprocated and carries water from *B* at each passage, when the level in the boiler falls below the top of the plunger.

The *feed-pump* of a marine engine has a plunger *a* attached to the cross-head *b* of the air-pump, and working through a stuffing-box in the pump-barrel *c*. *d* is the valve-box attached to the side of the hot-well; *e* is the suction-valve through which the water is drawn from the hot-well into the pump by the rise of the plunger. At the descent of the plunger the water is driven out at the valve *f* along the feed-pipe *g* to the boiler, unless the regulating valves or cocks to the boiler should be quite closed, when it raises the loaded valve *h* and returns to the hot-well by the aperture *k*. The load per square inch on the valve *h* must somewhat exceed the load per square inch of the steam in the boiler.

The lower portion of Fig. 1932 shows the feed-pump of the Cornish-engine, which has also a safety-valve, so that no injury may arise by shutting off the feed when the pump is at work.

Feed-rack. A stock-feeding device with grain-trough and hay-rack under shelter, which sometimes is extended to the stock also. In the example, the sheep are intended to be inside, and the hay introduced into the racks from the outside. The shed is

Fig. 1933.

Sheep Rack and Shelter.

made in sections to admit of removal on a wagon, and is placed on runners for movement in the field. The feed-troughs are opened on the outside for the introduction of hay, which is accessible through racks on the inside.

Feed-screw. (*Lathe.*) A long screw employed to impart a regular motion to a tool-*rest* or to the work; as the feed-screw in the bed of a lathe, which moves the screw-cutting tool.

Feed-wa'ter Ap'pa-ra'tus. An automatic device for supplying steam-boilers with feed-water. Of the very large number of devices for this purpose, many agree in one particular. A vertical pipe leading from a reservoir of water enters the top of the boiler, and its lower open end is at the lowest allowable level. In its normal condition the pipe is full of water, but when the level of the water falls below the level of the open foot of the pipe, steam enters the latter and water flows out till the foot of the pipe is again immersed. In some cases the steam is made to give an alarm at this point of depression of the water-level. See LOW-WATER ALARM.

Other forms of apparatus have valves operated by floats. See BOILER-FEEDER; FEED-PUMP, etc.

A form of feed-water apparatus by which water is taken on board the tender while the locomotive and train are in motion is adopted on some railways in the United States and in England. On the Hudson River Railway, for instance, at Melrose, is placed between the rails of the track a trough 1,200 feet long, 18 inches wide, 15 inches deep, and holding 16,000 gallons of water. The tender has a pipe with a nozzle pointing forward, and capable of being raised and

lowered. The train running at full speed, the nozzle is let down so as to pass two inches below the surface of water in the trough, and the water is thereby forced through the nozzle into the pipe and thence to the tender.

The plan was invented and patented by Angus McDonald of Virginia, 1854, but was first introduced in England.

Feed-wa'ter Heat'er. A device for heating the feed-water for high-pressure engines by passing it through a chamber traversed by a coil of pipe carrying the exhaust steam.

Feed-wa'ter Pump. See FEED-PUMP.

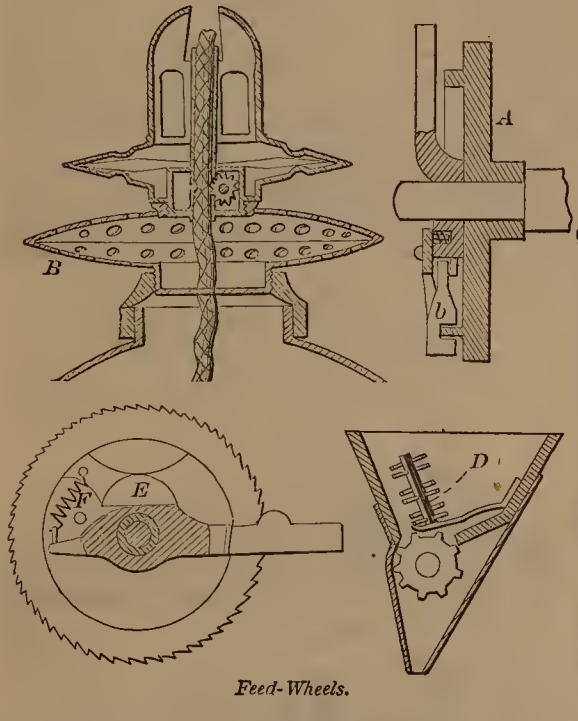
Feed-wheel. A continuously or intermittingly revolving wheel or disk which carries forward an object or material, as in the examples, where

B represents the feed-wheel as applied to a lamp-wick.

A, a binding feed by a slotted pawl on a flange of the wheel: this is similar to the cramp-feed, common in one form of saw-mill.

E is one form of sewing-machine feed. The lever being reciprocated at one movement, it clamps the

Fig. 1934.



Feed-Wheels.

block against the wheel and turns it, and on its return motion allows the block to slip in its seat in the inner periphery of the wheel.

D is a feed-wheel to regulate rate of passage of the seed from the hopper of a seeding-machine.

Fell. 1. (*Metallurgy.*) The finer portions of lead ore which fall through the meshes of the sieve when the ore is sorted by sifting.

2. (*Weaving.*) The end of a web, formed by the last thread of the weft.

3. The skin of a beast with the wool or hair on.

4. (*Sewing.*) A form of hem in which one edge is folded over the other and sewed down; or in which one edge is left projecting and is sewed down over the previous seam.

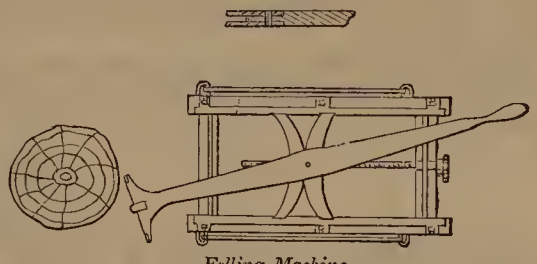
5. To cut down trees.

Fell'er. (*Sewing-machine.*) An attachment for making a felled seam, i. e. one in which two edges being run together are folded over and stitched.

Fell'ing-axe. One specifically adapted for *cutting down* timber, in contradistinction to an axe for *logging off*, *butting*, *lopping*, *hewing*, etc. See AXE.

Fell'ing-ma-chine'. One for cutting down standing timber. In the example, the vibrating

Fig. 1935.



Felling-Machine.

head has chisel and spur cutters, which are made to cut into the tree by the oscillation of the lever and the feed-movement of the carriage.

Other forms of machines for this purpose have gangs of augers, saws which cut kerfs from both sides simultaneously, and so on. It would appear that the contrivers have dropped but few trees, or that they have profited but little by their experience.

Not content with the sequoia trees which lay prostrate in the Calaveras grove, California, some enterprising vandals determined to fell one, which they did by using pump-augers, boring all around

Fig. 1936.

The Calaveras Redwood (Sequoia Gigantea).

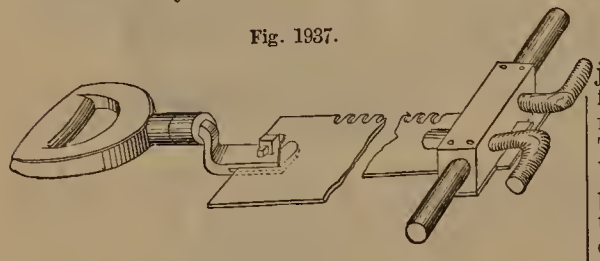
towards the center. The tree was 92 feet in circumference and 300 feet in hight. It stood so plumb that when it was cut clear by the augers it stood upright and had to be upset by wedges. The stump was then adzed off for a dancing-floor.

These trees are situated about seventy-five miles

east of Stockton, at an elevation of 4,700 feet above the level of the sea. The grove contains 92 trees, ten of which are 30 feet or more in diameter, 82 varying in diameter from 15 to 30 feet. In hight they range from 150 to 327 feet, the tops of many of the larger having been broken off by the wind or snow. The age of the trees is supposed to vary from 1,000 to 3,500 years.

Fell'ing-saw. This has a taper blade about 6½ feet long, with gullet-teeth, and operated like the cross-cut saw by a man or men at each end. The

Fig. 1937.



Felling-Saw.

handle at the wide end is fixed by an iron bolt and wedge. The handle at the narrow end is calculated for two men, and the saw is held in this handle by a wedge which is driven out when the saw is to be removed from the kerf. Wedges are driven into the kerf to prevent the blade from being jammed, and the saw is withdrawn from the kerf endways.

Fel'loe. The rim of a wheel or one of the annular segments thereof. See FELLY.

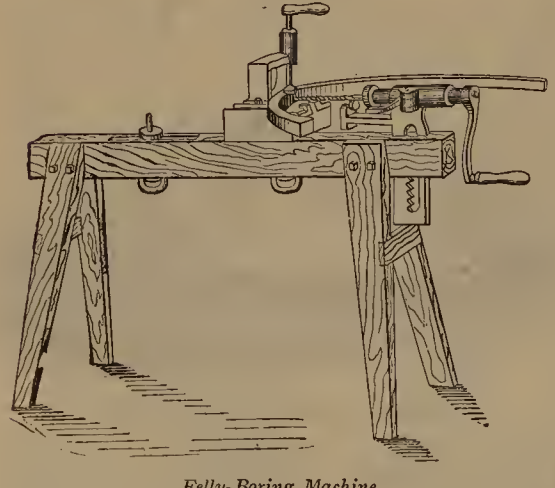
Fel'ly. (*Vehicles.*) A segment of the rim of a wooden wheel. When the perimeter is in one or two portions of bent stuff, it is a *rim*, or made of two *half-rims*. *Felloe.*

Fel'ly-au'ger. A hollow auger for fashioning the round tenon on the end of a spoke. A pod-auger for boring the hole in the felly to receive the spoke, or the holes in the ends for the dowel-pins.

Fel'ly-bend'ing Ma-chine'. A machine with a segmental or circular former around which felly-stuff is bent to a curved shape and held till it has cooled and dried in its assumed shape.

Fel'ly-bor'ing Ma-chine'. One having a vertically adjustable boring apparatus attached to an ordinary trestle, and with a clamp to hold the felly

Fig. 1938.

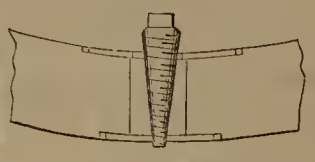


Felly-Boring Machine.

in position. Stops on the adjustable rest against which the bit-holder brings up limit the depth of the holes. At the front of the vise-block which holds the felly are two guide-irons, to keep the same in position when dowel-holes are bored.

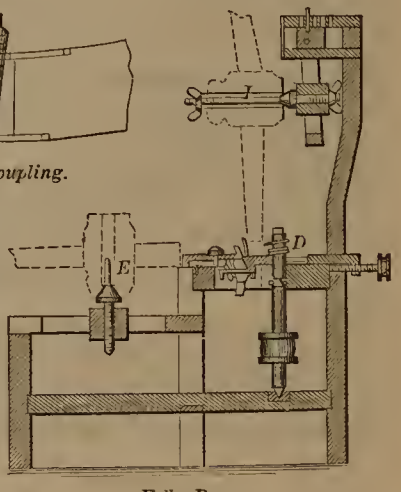
Fel'ly-coup'ling. A box for enclosing the ad-

Fig. 1939.



Felly-Coupling.

Fig. 1940.



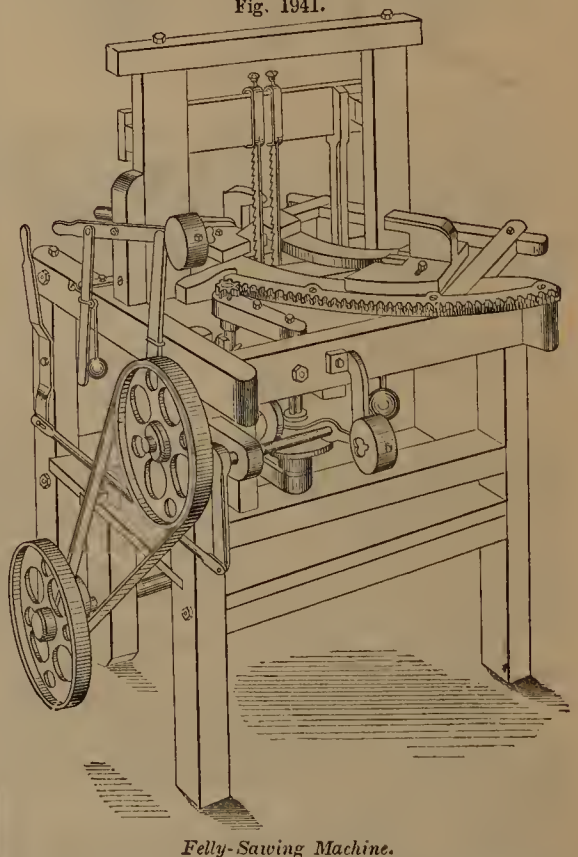
Felly-Dresser.

jacent ends of fellies in the rim of a wheel. The sectional block is expanded by the taper screw to expand the fellies and tighten the tire.

Fel'ly-dress'er. A machine for dressing the edges of fellies, the wheel being chucked upon a spindle *I* above so as to bring each part of the rim of the wheel in turn to the revolving cutter *D*. To dress the periphery of the rim, the wheel is chucked on the spindle *E*.

Fel'ly Saw'ing-ma-chine'. A machine for sawing stuff into fellies. The block is placed on a segmental bed which oscillates on a center and brings the stuff against a pair of gig-saws, which are gaged

Fig. 1941.



Felly-Sawing Machine.

at a distance apart which determines the side width of the spoke, while the distance they work from the

center of oscillation of the swinging frame determines the radius of the circle of which the felly is an arc.

Felt. 1. (*Fabric.*) Fur and wool fibers have barbed surfaces inclined from the root towards their tips. Under the influence of friction and heat these barbs spread out from the main fiber, and, like the tendrils of a plant, catch hold of other fibers and eling to them. When a mass of such fibers are disposed in all directions, they readily interlock and consolidate into a compact fabric. As these barbs all incline in one direction, the fibers can readily work into a mass of fibers, partially felted, but-end foremost. This is called *sizing*, and is produced in napping hats.

Felt probably preceded woven fabrics. In Central Asia, the home of the argali, from whence the domestic sheep has probably sprung, the clothing and tents of the people are yet, and have been since the first recorded times, felted fabrics. The latticed huts referred to by Herodotus, and Æschylus are covered with felt, of which also the flapping screen which answers for a door is made. See WAGON. Marco Polo (thirteenth century) describes them fully. Klaproth describes them as of goat's hair (see HAIRCLOTH), and having a shaggy villus on the outside. The Chinese traveler, Chi-fa-hian, who visited India in the fourth century, describes the people of Chen-chen, who lived about the Lake of Lob, as wearing dresses of Chinese cut, but made of felt. Felt covered the funeral pile of Hephæstion, whose obsequies were so splendidly celebrated by Alexander; Xenophon says that felt was used to cover chairs and couches; the Medes also used felt for sacks.

The word *felt* is allied to the Greek *pilos* and Latin *pilus*, from a root word which means to *compress*. The Greek word *pilotos* — felted — comes strangely near the English *pilot*-cloth in name and meaning, not but that the latter is woven before being thickened by the act of compression (Latin, *cogo*, *coactus*, whence *coactilis*).

> "Lanæ et per se coactæ vestem ficiunt."
>
> PLINY.

The principal use of felt among the Greeks and Romans was in the manufacture of caps and hats. (See HAT.) The art of felting no doubt passed from Central Asia into Greece. In the time of Aristotle, besides the felt hats (*petasi*), the helmets were lined with felt (*pilos*) or sponge.

The mantles of Circassia and Phrygia to this day are heavy, stiff, and rain-proof. Colonel Leake describes a postilion's dress in Phrygia as a cloak of white camel's hair half an inch thick and stiff enough to stand alone when set on the ground. It had neither sleeves nor hood, but holes for the hand and projections like wings on the shoulders to turn off the rain.

The Armenians of Schamachi lead a nomadic life in movable huts constructed of wicker-work covered with felt, and with mats made of reed-grass.

The Nogai Tartars of the Caspian have similar shelters.

The hatters attribute the art of felting to Clement. The hatters are a very modern guild, and cannot antedate their order beyond the year 1400.

Dr. Hooke lectured on felt-making before the Royal Society, 1666. — PEPYS.

The mechanical features of the operation of felting are derived from the jagged character of the edges of some animal fibers, which enables them to pass in one direction, that is, root first, but opposes their withdrawal. The most familiar illustration of this feature is an awn of barley, a beard of wheat, or a head of grass of some kinds. These, as we all know, when introduced but-first between the wrist and the sleeve, will crawl up the arm and strongly oppose withdrawal. The teeth are presented towards the point, and resist a force applied from that direction.

If we take a human hair, hold it fast by the root-end, and draw it gently between the finger and thumb, it passes smoothly and without sensible interruption; but if we reverse the direction of motion, a sensible crepitation is experienced. If we gently press a hair between the finger and thumb, and give it a rolling motion, it will advance root first, whatever may be the position of the root in respect to the two rubbing surfaces. A fiber of wool operates in the same way, moving root first; so do the hairs which are adapted for felting when similarly treated.

The jagged structure is visible in the beard of wheat and barley, and the microscope reveals it in the hair and wool referred to.

It would be interesting to introduce various other examples of hair and wool, as seen under the microscope, but our limits forbid. *a*, in the illustration, shows the appearance under a microscope of a fiber of Saxony lamb's wool somewhat less than $\frac{1}{1000}$ of an inch in diameter.

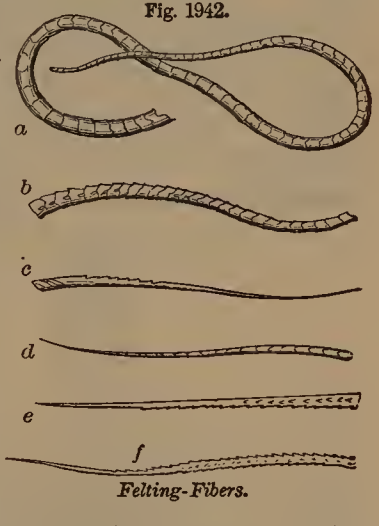


Fig. 1942.
Felting-Fibers.

f shows the appearance of rabbit-hair under the microscope, and *b* beaver-down, which has a diameter of about $\frac{1}{2000}$ of an inch. *c*, *d*, *e*, show musquash, nutria, and hare's fur. They all show the jagged edge which confers upon them the characteristic felting quality.

Wool in the yolk, with the natural grease (*suint*) adhering to it, will not felt, because in this state the asperities of the fiber are filled and smoothed over, just as oil destroys the action of very fine files. Fine wool that has been scoured has strong tendency to mat or felt together, and must be oiled to enable it to be carded and spun successfully.

The hair of rabbits, hares, and some other animals, is used in Russia as a felt foundation for bowls, dishes, plates, etc. It is brought to shape and then varnished; when complete, the utensil resembles papier-maché or varnished leather, and is light and durable.

English patent 1,403 of 1862 cites the use of the silky down of *typha* or bulrush. The down is separated from the seeds by a willowing process and blown over into a chamber. It is mixed with one third or half the quantity of rabbit's hair, and worked by the usual processes into hats, caps, and fabrics; or mixed with silk, wool, cotton, or flax to form a fabric for shoe-soles, paper, etc.; or mixed with caoutchouc or gutta-percha for bands, belts, carriage-fitting, accouterments, pipes; as a substitute for cork, book-covers, etc.

The uses of felt are various; among them may be cited the following: —

Among the Asiatics: cloth, hats, carpets, tent-coverings, socks.

In the United States and Europe, for domestic purposes: cloth, clothing, socks, slippers, boot and shoe soles and insoles, hats, caps, gloves, carpets, and table-covers.

Surgeons' bandages and saddle-cloths.

Mechanical: clothing for steam-boilers and cylinders; deadening for walls and floors; non-conductors for kilns and refrigerators; roofing charged with bitumen or other water-repellant; steam-packing; lining between the planking and copper-sheathing of ships; polishing-wheels; hammers of pianos; elastic blankets for printing-presses; covers of books.

2. The felted cloth on which paper is couched and carried in the paper-making machine. The cloth on which the paper is couched from the *making* cylinder is known as the *making* felt. Others as *carrying* felts, *first* felt, *second* felt, etc. Appurtenances of the *felt* are known as felt-washers, felt-rollers, etc.

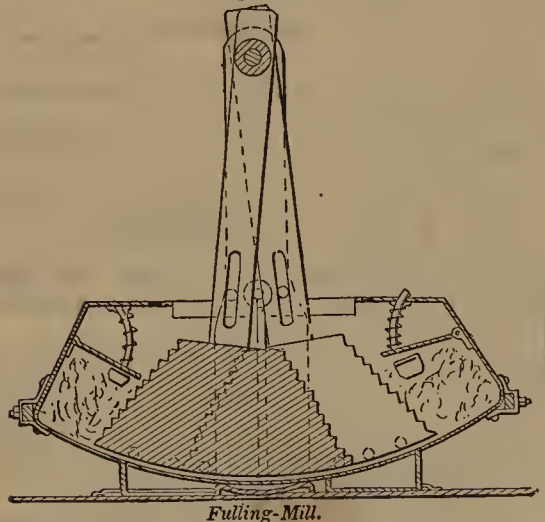
Felt-car'pet. A carpet whose fibers are not spun or woven, but are associated by the felting process.

Felt'ed Cloth. (*Fabric.*) Cloth made by felting, without spinning or weaving, was patented in England by Williams, in February, 1850.

Felt-grain. (*Wood-working.*) The grain of wood whose direction is from the pith to the bark; the direction of the medullary rays in oak and some other timber.

Felt'ing-ma-chine'. Felting-machines are of various kinds. 1. For acting upon the material in mass, as in the fulling-mill (Fig. 1943), where the cloth in a bath of soap-suds is pounded by the stock, which swings like a pendulum on its bearings above.

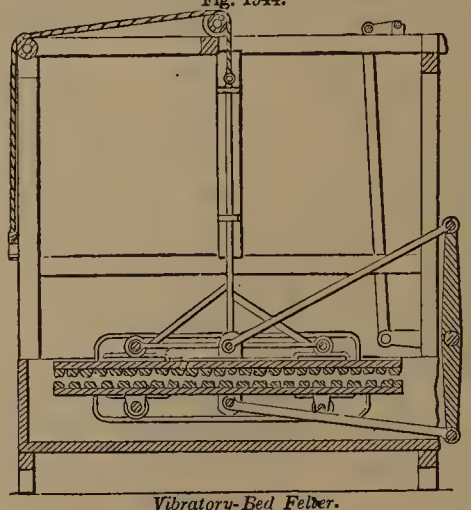
Fig. 1943.



Fulling-Mill.

2. A lower reciprocating bed mounted on grooved rollers running on tracks secured in the vat; the other bed being attached to grooved rollers that run between a double track above. The beds are worked in opposite directions by a double-action lever connecting therewith; the material placed between the beds and exposed to a rubbing action while immersed in hot water. (Fig. 1944.)

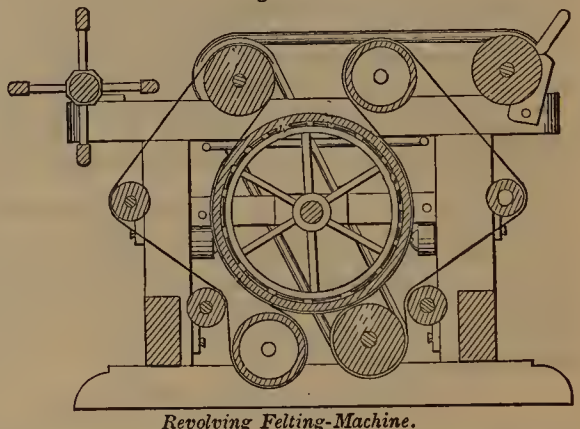
Fig. 1944.



Vibratory-Bed Felter.

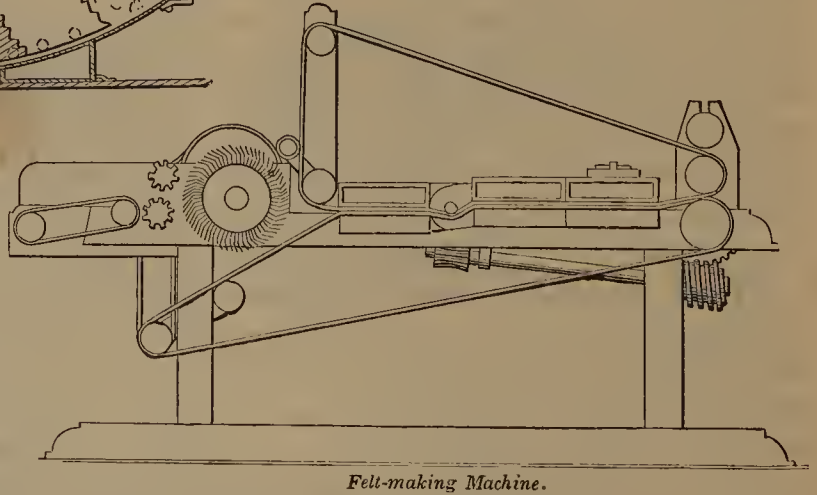
Fig. 1945 shows a form in which the main cylinder, having a cork surface, acts upon yarn or cloth carried between it and the fibrous belts which pass around steam-heated cylinders, and motive and idler rollers. Perforated pipes beneath the belts throw hot water upon them.

Fig. 1945.



Revolving Felting-Machine.

Fig. 1946.



Felt-making Machine.

In Fig. 1946 the fiber is placed on a feed-apron, passes between two fluted rollers to a card-cylinder, and is then taken between two endless aprons over

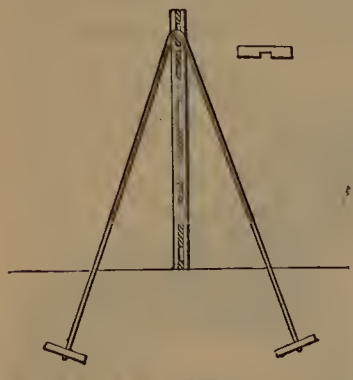
the series of tables, and beneath the longitudinally and transversely reciprocating platens. The combined heat, wet, and rubbing action consolidates the bat of fiber into a felted web.

Fe-luc'ca. (*Vessel.*) A small vessel propelled by oars and lateen sails; used in the Mediterranean and adjacent waters for coasting voyages.

Fem'er-ell. (*Carpentry.*) A louvre lantern in a roof for the escape of steam and smoke, or for ventilation.

Fence. 1. A structure on the boundary of a lot, field, or estate to keep off intruders, or act as a screen.

Fig. 1947.



Anchored Fence.

Among the varieties of fences are the *wall*, of brick or masonry; *post-and-board; post-and-rail; rail* or *worm* fence; *post-and-wire; paling; iron; portable; sunk* or *ha-ha; hedge.*

When stronger than most of these, the fence may rise to the dignity of a scarp, palisade, stockade, parapet, and constitute an important defensive line.

The Roman fences were four in number: —

1. The *Sepimentum naturale*, or live fence of thorn.

2. The *S. agreste*, or wooden paling interlaced with withes, or bored and strung on longitudinal rails.

3. The *S. militaire*, having a bank (*agger*), ditch (*fossa*), and *vallum*, or row of stakes on the bank.

4. The *S. fabrile*, or wall of stone, brick, adobes, or mud.

Room here can be afforded for but a bare hint of the diverse kinds.

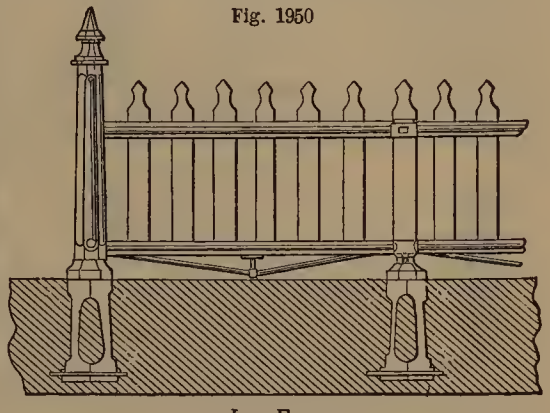
Fig. 1947 shows a mode of supporting panels of board fence standing in line; stay-rods passing over the top of the fence and being anchored below the surface.

Fig. 1948 shows a mode of hanging fence-panels to posts.

Fig. 1949 is a portable fence in which the panels rest between posts which are planted in sills and stayed by inclined bars which form buttresses.

Fig. 1950 is a more pretentious fence of iron posts set in grouting and ornamental panels.

Fig. 1950



Iron Fence.

Fig. 1951 is a post, wire, and paling fence.

2. (*Wood-working.*) An adjustable guard-plate or edge on a gage, or on a *grooving, banding, plow, fillister*, or *reglet plane*, by which the distance of the groove from the guide-edge is regulated.

A straight edge on the work-table of a *circular, band*, or *scroll saw*, or of a *planing, molding*, or *mortising machine*. It acts as a gage and guide, and is adjustable to any required distance from the tool.

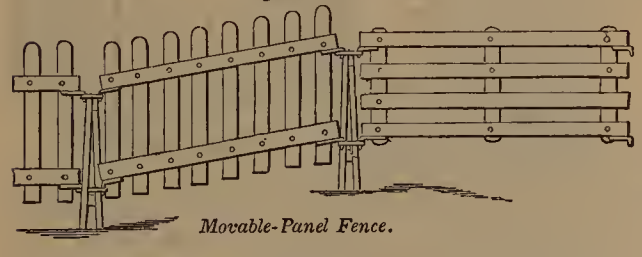
The fence may be swiveled so as to have a capacity for angular presentation of the work.

3. The arm of the hammer-spring of a gun-lock.

4. (*Locks.*) An arm or projection which enters the gates of the tumblers when they are adjusted in proper position and coincidence, and at other times prevents such movement of the dog, stump, or other obstructing member as would permit the retraction of the bolt.

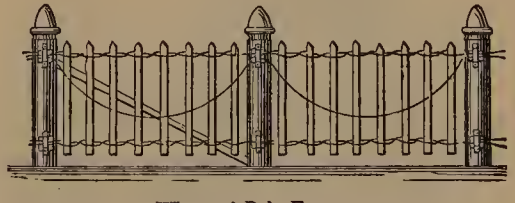
In common tumbler locks the fence forms the obstructing medium between the bolt and the tumblers, to prevent the retraction of the former when the tumbler-gates are not in coincidence.

Fig. 1948.



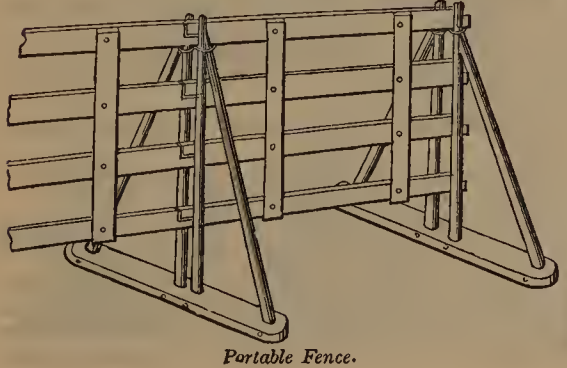
Movable-Panel Fence.

Fig. 1951.



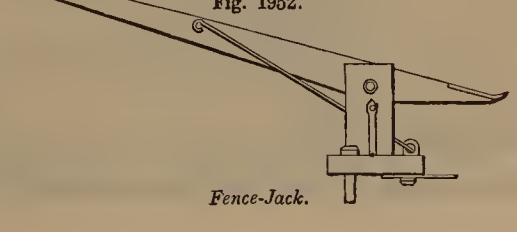
Wire and Pale Fence.

Fig. 1949.



Portable Fence.

Fig. 1952.

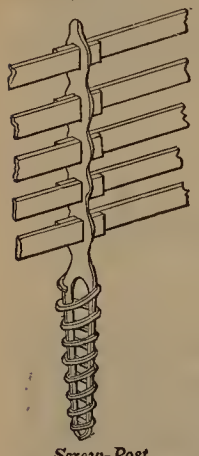


Fence-Jack.

Fence-jack. A lever jack adapted for lifting the corner or *lock* of a worm-fence in order to lay in a new bottom-rail, a fence-chunk, or a stone.

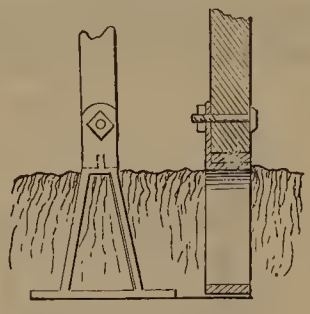
Fence-post. A piece of timber or a structure of other material, planted vertically in the ground,

Fig. 1953.



Screw-Post.

Fig. 1954.

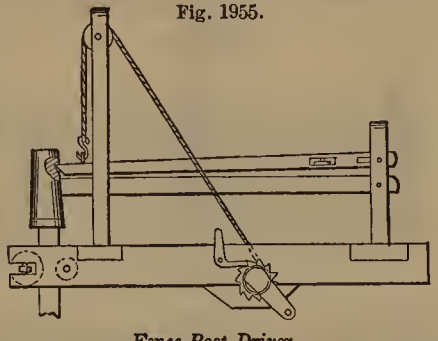


Anchor-Block and Post.

to hold panels of fence. Ingenuity has principally been exercised in contriving modes of saving timber in fences for prairie countries, and in structures as substitutes for the usual wooden posts. Two suggestive forms are shown in Figs. 1953 and 1954. One is an iron post with a spiral rib which answers as a screw for inserting it. The other is an anchor-block, to which the vertical slat of a fence is bolted.

Fence-post Driv'er. A device like a trip-hammer or pile-driver, mounted upon wheels, and used for driving fence-posts which have been previ-

Fig. 1955.



Fence-Post Driver.

ously sharpened. After the hammer attains its hight, the rope is cast off suddenly and the hammer drops.

Fenc'ing-gage. An implement to space and hold boards against a post while nailing them. The upright cleat *A* is temporarily tacked to the post, and the pegs afford rests for the lower edges of the boards.

Fig. 1956.

Fencing-Gage.

Fenc'ing-nail. A heavy nail of its class, adapted for fastening on fencing-boards.

6^d, 7^d, 8^d, 9^d, and 10^d nails are made for this purpose nearly twice the weight of the common nails of these numbers.

Fend'er. A contrivance to fend off an object so as to prevent the bruising of the structure so protected.

1. An upright timber placed against the edge of a pier, dock-wall, or wharf, to prevent injury to the wall by the contact of vessels, drift, or floating ice. A *fender-pile.*

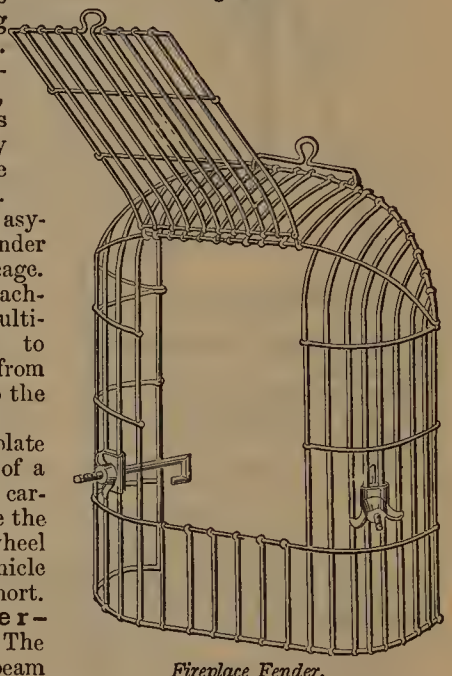
2. A mass of old rope stuffed into a heavy, open net made of rope, and placed between the sides of a vessel and the quay or pier with which it is about to collide, in order to deaden the blow and prevent injury to either of the contacting objects.

A piece of oak on a vessel's side to protect it from chafing by objects which are being hoisted aboard.

On the river steamboats of the West, poles hang overboard, being suspended from the upper guards, and answer the same purpose. Fancy rowing-boats, wherries, and man-of-war boats have fenders which hang outside the gunwale.

3. A structure in front of a fire or fireplace, to keep children or lunatics from burning themselves. In the example shown, the fender is secured by hooks to the grate-bars. In lunatic asylums the fender is a large cage.

Fig. 1957.



Fireplace Fender.

4. An attachment to a cultivator-plow to keep clods from rolling on to the young corn.

5. A rub-plate on the bed of a wagon or carriage to take the rub of the wheel when the vehicle is turning short.

Fend'er-beam. 1. The horizontal beam into which the posts of a saw-mill gate are framed at top. The fender-beam in Perley and Pattee's saw-mill at the Chaudiere Falls, Canada, is pine stock, 84 feet long and squared to 24 × 28 inches.

2. The inclined advance piece of an ice-breaker.

3. A beam suspended over a vessel's side to ward off ice and preserve the planking and sheathing of the vessel.

Fend'er-bolt. (*Shipbuilding.*) One having a large head which projects from the planking and serves as a fender to save the planks from being bruised.

Fend'er-pile. A pile fixed in front of a pier, wharf, or river wall, to ward off the blows of running ice, drift, vessels, etc.

Fend'er-post. One of the guiding stanchions of a saw-gate.

Fend'er-stop. (*Railroad Engineering.*) A structure at the end of a line of rails, to stop the carriages or engine, if needful.

Fe-nes'tra. (*Architecture.*) A window; an entrance.

Fe-nes'trai. Window-blinds or casements closed with paper or cloth, instead of glass.

Fer-ment'ing-square. (*Brewing.*) An oblong or square shallow vat in which wort is fermented.

Fer-ment'ing-vat. A tank or tun in which wort is placed to undergo the fermentation resulting from the addition of the yeast. Certain arrangements for keeping the liquid at the desired temperature in the

heat of summer or cold of winter are added in some cases.

Fer-ran'dine. A mixed stuff of silk and other materials, formerly worn. It is referred to by Pepys in his "Diary," about 1667. The word was sometimes written *farandam* or *farendone*. It probably resembled *poplin*.

Fer'ret. 1. (*Glass.*) An iron used to make the rings at the mouths of bottles, or to try the melted matter.

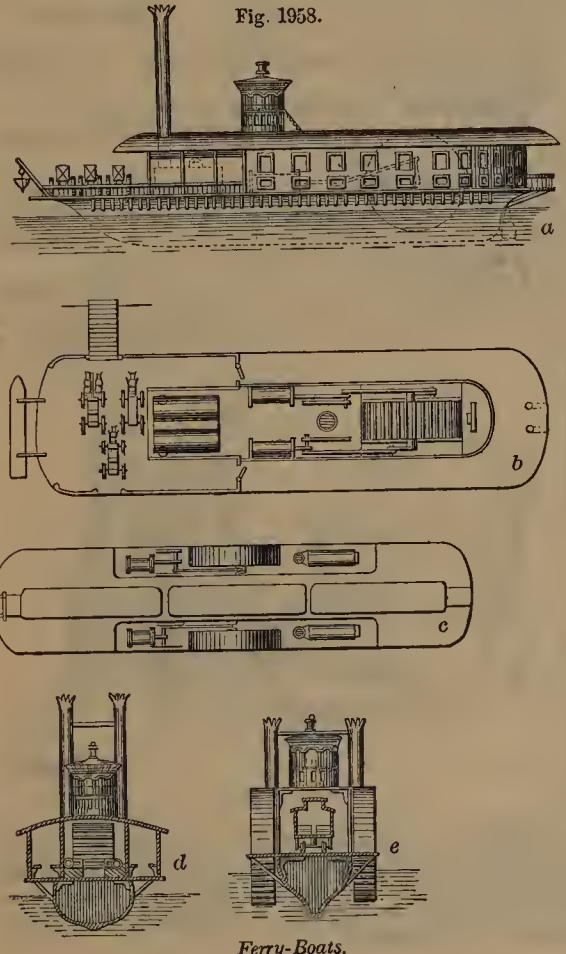
2. *Floret*, or floss-silk.

Fer-ret'to. (*Glass.*) A preparation of copper employed in glass-coloring. It is made by placing thin sheets of copper interstratified with powdered brimstone in a crucible which is luted tight and exposed to the heat of a blast-furnace for about two hours; when cool, the copper is found to be calcined so as to be readily crumbled between the fingers; it is then pulverized and sifted for use. A superior article to the foregoing is prepared by using vitriol instead of brimstone, and exposing the crucible to the heat of the glass-furnace for three days. The old vitriol is then replaced by fresh, and the heating operation repeated six times.

Fer'ro-type. (*Photography.*) A process, so named by Hunt, which derives its name from the material of the plate (iron) on which it is taken. Plates of sheet-iron are covered with a surface of black Japan varnish. This is immersed in collodion, and after a time in the silver solution. It is then placed in the holder and exposed in the camera.

Fer'rule. 1. A short tube or thimble made slightly conical, and used to fasten the tubes in the sheet-plates of steam-boilers. Except at the point, the ferrule is a little larger than the bore of the tube, and when driven in it compresses the tube forcibly against the sides of the hole in the tube-sheet, making a steam-tight joint.

Fig. 1958.



Ferry-Boats.

2. A metallic ring or sleeve on the handle of a tool or the end of a stick, to keep the wood from splitting.

Fer'ry-boat. (*Vessel.*) A vessel for carrying passengers and freight across a river or estuary.

a, an elevation of the steam ferry-boat for ordinary travel crossing the Missouri River at Omaha.

b is a plan-view of the same, showing the single wheel amidship, the engines and boilers.

d is a transverse vertical section of the same, showing the cabins over the guards.

e is a transverse vertical section of a ferry-boat for railway-cars at La Chine, river St. Lawrence. It has side-wheels and a track amidship.

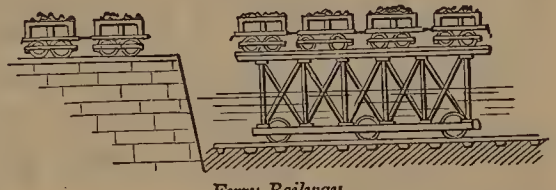
c is a plan-view of the same.

Fer'ry-bridge. A form of ferry-boat in which the railway-train moves on to the elevated deck, is transported across the water, and then lands upon the other side. Tramways forming inclined approaches are adjustable to the requirements of different stages of water in the river, or states of the tide in estuaries. The ferry-bridge which preceded the present bridge over the Susquehanna at Havre-de-Grace is a notable instance.

Ferry-bridges are also to be found in Europe, which cross by means of chains laid across the river, and chain-wheels on board rotated by an engine.

Fer'ry-rail'way. One whose track is on the bottom of the water-course and whose carriage has an elevated deck which supports the train.

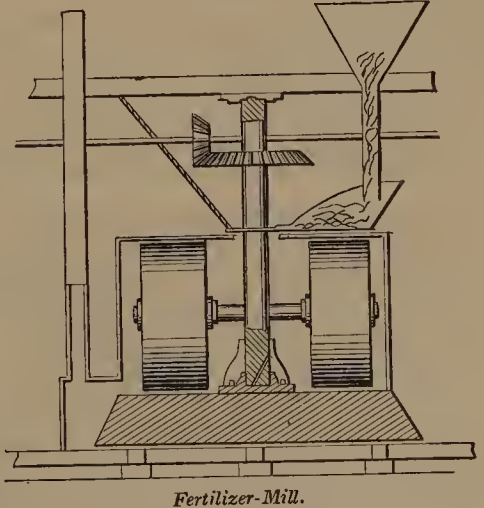
Fig. 1959.



Ferry-Railway.

Fer'ti-liz'er-mill. One in which the materials are ground to powder so as to be sown from a machine. The illustration shows a Chilian mill adapted to the purpose. Phosphatic minerals, bones, and various materials are thus ground.

Fig. 1960.



Fertilizer-Mill.

Fer'ti-liz'er-sow'er. A form of seeding-machine adapted to sow granulated manures, such as dry poudrette, the phosphates, bone-dust, lime, guano, etc. It sometimes forms a machine by itself, and sometimes is an attachment to a wheat-drill; in England, also to a turnip-drill.

Fes-toon'. (*Architecture.*) An ornament like a garland. Common on friezes.

Fet'lock-boot. (*Menage.*) A protection for the fetlock and pastern of a horse. See INTERFERING-ATTACHMENTS; LEG-GUARD.

Fet'ter. A chain for the feet. See HOPPLE.

Fet'tling. 1. (*Metallurgy.*) The material, consisting of ore, cinder, and scrap-iron, mixed in varying proportions, and used in preparing the hearth of a puddling-furnace before receiving its charge of iron. *Fettle* is an old English word signifying to prepare, and corresponds to the American word *fix*. *Fixing* is the term used in the United States to signify this preparation of the hearth.

2. (*Pottery.*) The shaving and smoothing of green clay-ware to remove the appearance of seams from articles that are molded, and to smooth asperities.

Feuil-lets'. (*Diamond-cutting.*) The projecting points of the triangular facets in a *rose-cut* diamond, whose bases join those of the triangles of the central pyramid.

Fi-a'cre. A French hackney-coach.

Fi'ber-gun. A device for disintegrating vegetable fiber. Lyman's patent, No. 21,077, of 1858. Flax, hemp, jute, cane, or wood are placed in a cylinder and charged with hot water, steam, gas, or air under great pressure; the cover of the cylinder being suddenly removed, the mass is projected into a chamber where the sudden expansion of the fluid under pressure ruptures the cells and tears the fibers apart.

Attempts have been made with more or less success to use this system of rapid exclusion of the matter, under pressure of generated carbonic acid, resulting from the treatment of the material first with a caustic alkali and then with acid. See COTTONIZING FIBER.

Fi'ber, Treat'ment and Man'u-fac'ture of. See list under COTTON, FLAX, WOOL, HEMP, etc., APPLIANCES.

Fib'u-la. (*Surgical.*) A needle for sewing up wounds.

(*Masonry.*) An iron crank by which stones are fastened together.

Fid. 1. (*Nautical.*) *a.* A bar of wood or iron to support a mast upon the one beneath. It passes through a mortise in the upper mast, and rests on the trestle-trees of the head of the mast below.

b. A wooden, pointed pin used to open the strands of a rope in splicing. A similar iron instrument is a *marlinspike*, or, as used by sail-makers, a *stabber*.

2. A plug of oakum for the vent of a cannon.

Fid'dle. 1. (*Music.*) An instrument played with a bow, and having four strings, stretched over a sounding-board to give resonance, and along a neck (without frets) upon which the strings are pressed by the fingers to vary the tone. See VIOLIN.

Locusts are fiddlers. Their hind legs are the bows, and the projecting veins of their wing-covers the strings. On each side of the body in the first segment of the abdomen, just above and a little behind the thighs, is a deep cavity closed by a thin piece of skin stretched tightly across it, like a banjo-cover. When a locust begins to play, he bends the shank of one hind leg beneath the thigh, where it is lodged in a furrow designed to receive it, and then draws the leg briskly up and down several times against the projecting lateral edge and veins of the wing-cover.

From a ballad of the fourteenth century, or thereabouts, cited in Watson's "History of English Poems," occurs, —

> "Syre Ladore latte made a feste
> That was fair and honeste,
> With his lord the kynge;
> Ther was much minstralse,
> Trompus, tabors, and santre,
> Both harp and fydyllynge."

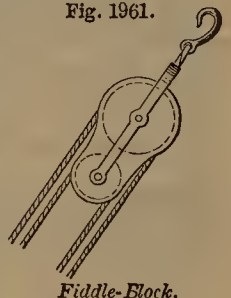
A monumental brass of the same period in St. Margaret's Church, King's Lynn, Norfolk, England, shows the musicians at a peacock feast; one has a four-stringed fiddle, another a six-stringed cithern.

2. (*Husbandry.*) A wooden bar about 11 feet long, attached by ropes at its ends to the traces of a horse, and used to drag loose straw or hay on the ground, or hay-cocks to the place of stacking. A rope or grape-vine answers very well for the latter purpose.

3. (*Nautical.*) A frame of bars and strings, to keep things from rolling off the cabin table in bad weather.

Fid'dle-block. A long block, having two sheaves of different diameters in the same plane; not as in a *double-block*, where they are in parallel planes. A *viol*-block.

Fig. 1961.



Fiddle-Block.

Fid-ham'mer. (*Nautical.*) A hammer with a face for striking and a pointed *peen* to act as a *fid*.

Field. The space visible in an optical instrument at one view. By shifting the telescope, the *field* is changed; by shifting the slip or object relatively to the object-glass of a microscope, successive parts of the object are brought within the *field*.

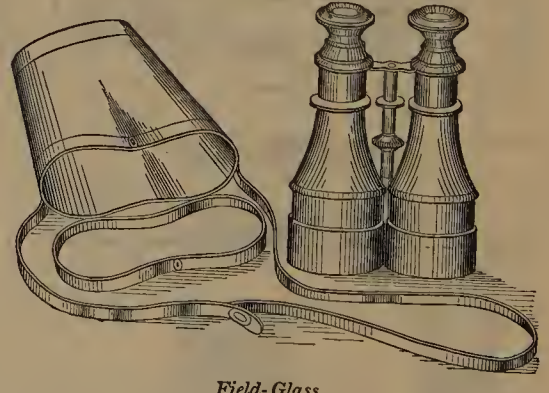
Field-bed. A folding-bed for camp use.

Field-book. The book in which the memoranda of surveys are made.

Field-der'rick. One used for stacking hay in the field. It is mounted on a sled or on a sill-piece which is anchored temporarily by stakes; otherwise it is stayed by guys.

Field-glass. 1. *a.* A binocular telescope in compact form, and having six achromatic lenses. It has a metallic body covered with morocco, and a

Fig. 1962.



Field-Glass.

sun-shade to extend over the object-glasses. It is carried in a leather case with a strap, and has a body $3\frac{3}{4}$ to $6\frac{1}{4}$ inches long, the object-glasses being from 15 to 26 lines in diameter. A *lorgnette*. An *opera-glass*. A *race-glass*.

b. A small achromatic telescope, usually from 20 to 24 inches long, and having 3 to 6 draws.

2. That one of the two lenses forming the eye-piece of an astronomical telescope or compound microscope, which is nearest to the *object-glass;* the glass nearest to the eye is the *eye-glass.*

Field-gun. A light cannon designed to accompany troops in their maneuvers on the field of battle. At the commencement of the late civil war in this country, those thus denominated were the 6-pounder, weighing 885 pounds; the 12-pounder, of 1,770 pounds; a light 12-pounder of 1,220 pounds; and the 12, 24, and 32-pounder howitzers, weighing respectively 780, 1,320, and 1,820 pounds. These were all made of bronze. During the war several kinds of rifled field-guns were introduced, but only two maintained their place in the military service; the 3-inch wrought-iron rifle and the Parrott 10-pounder of 2.9-inch caliber, each nearly the weight of the bronze 6-pounder, and carrying an elongated projectile of ten pounds weight. The smooth-bores generally were withdrawn from the field during the war, with the exception of the light 12-pounder, or "Napoleon" gun.

Four smooth-bore guns and two howitzers, or six rifled or six 12-pounder guns with their carriages, caissons, forge, and battery-wagon, constitute a battery. No particular kind of breech-loading gun has been adopted in the United States Service, unless the Gatling machine-gun may be so classed. See BATTERY-GUN. Most, if not all, European governments have adopted breech-loaders of various kinds for field service.

The English use the breech-loading Armstrong gun (see ARMSTRONG-GUN) for field, fortification, and naval service.

The Prussian army uses two calibers of field-guns, 4 and 6 pounders, both rifled steel breech-loaders. The bore of the barrel extends entirely through. The breech of the 4-pounder is closed by a double wedge sliding in a horizontal slot through the barrel. The 6-pounder is closed by a plug held in place by a large steel pin. The escape of gas is prevented by a gas ring on the Broadwell plan, similar to that in a Sharp's rifle. See GAS-RING.

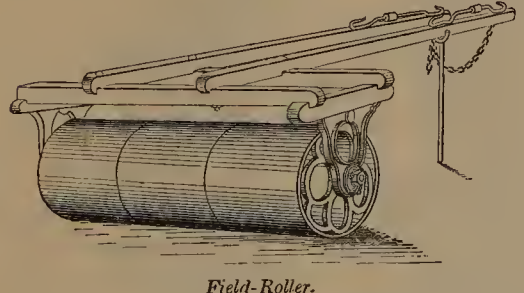
Field'ing. Exposure to the open air and sun of *malt-wash,* or *gyle* in casks, in order to promote its acetification.

Exposure to artificial heat is termed *stoving.*

Field-lens. See FIELD-GLASS, 2.

Field-roll'er. (*Husbandry.*) A wooden or iron

Fig. 1963.



Field-Roller.

cylinder, drawn over a plowed field to mash the clods and level the ground.

Field-staff. A gunner's staff for carrying a lighted match.

Field-tel'e-graph. One adapted for use in the field in military operations.

The field-telegraph of the German army consists of 140 men, 10 wagons, and 40 miles of wire for each army corps in the field. The wire is reeled out of the wagons and mounted on light poles about ten feet high, every third one being put in the ground. One eighth of the whole length of wire is insulated, and may be run along the ground.

Field-works. (*Fortification.*) These are of three kinds: —

1. Works open at the gorge: —
   a. Redans, single and double.
   b. Lunettes.
2. Works closed all round: —
   a. Redoubts.
   b. Star forts.
   c. Bastioned forts.
3. *Lines,* continued or broken. See LINE.

Fife. (*Music.*) A small pipe used as a musical instrument; the usual accompaniment of the drum.

Fife-rail. (*Nautical.*) A banister on the break of a poop or around the mast of a vessel.

Fif-teenth'. (*Music.*) A stop of an organ tuned an octave above *principal;* two octaves above *open diapason.* See STOP.

Fifth-chain. The chain by which the single lead horse in a team of five is hitched to the end of the tongue. It is supported by chains from the harness of the leading pair.

Fifth-wheel. A wheel or segment above the fore-axle of a carriage and beneath the bed. The king-bolt is the center of oscillation, and the *fifth-wheel* forms an extended support to prevent the careening of the carriage-bed.

In the example, one part is shown in section to

Fig. 1964.

Fifth-Wheel.

exhibit the anti-friction rollers which traverse on that portion of the segment attached to the axle.

Fig'ured-fab'ric Loom. In *figure-weaving,* the cloth is ornamented with flowers and other devices. The warp is divided among a number of heddles which are operated by separate treadles, by which different colors may be concealed or brought to the surface, or made to change places according to a presented pattern. The Jacquard is the principal loom used in weaving figured fabrics. See DAMASK; JACQUARD.

Hohlfield, of Hennerndorf, in Saxony, 1711–71, invented a loom for weaving figured fabrics, the model of which is preserved in the collection of the Berlin Academy.

Fig'ure-head. (*Nautical.*) The ornament on the head or prow of a ship.

Fi'lar-mi-crom'e-ter. A micrometer having threads or wires across its field of view. It was invented by Malvasia about 1660, who applied a network of fine silver wires crossing each other at right angles, and dividing the field of the telescope into squares. See WIRE-MICROMETER.

File. A steel instrument for abrading or smoothing surfaces, and having raised cutting edges (teeth) made by the indentations of a chisel.

Files are mentioned in 1 Samuel xiii. 21, 1093 B. C. "They had a file for the mattocks and for the colters, and for the forks and for the axes, and to sharpen the goads."

Files are graded by *shape*, *size*, and *fineness* of cut; and also known by their *purpose*.

As to *shape*, the diagram (Fig. 1965) giving a series of sections will be readily understood.

a, *b*, *c*, *d*, *e*, *f*, *g*, *h*, are sections derived from the square.

i, *k*, *l*, *m*, *n*, *o*, *p*, *q*, are sections derived from the circle.

r, *s*, *t*, *v*, *w*, *x*, *y*, *z*, are sections derived from the triangle.

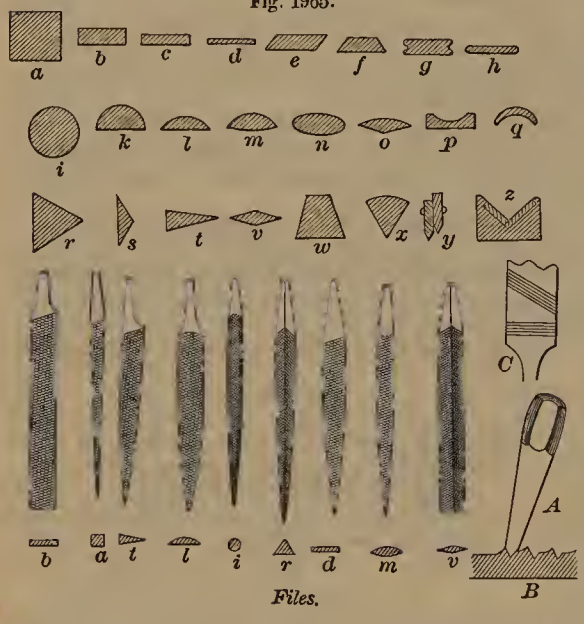
a, *square* file, parallel or taper, sometimes with a *safe* side.

b, when large, a *cotter* file; small, *verge* or *pivot* file.

c, *flat* file: when small, *pottance* file; when narrow, *pillar* file.

d, when *parallel*: *equaling*, *clock-pinion*, or *end-*

Fig. 1965.



Files.

less-screw file. When *taper*: *slitting*, *entering*, *warding*, or *barrel-hole* file.

e, *f*, *French-pivot* or *shouldering* file; *parallel V-*file.

g, *nail* file, for the finger-nails.

h, *pointing mill-saw* file, *round-edge* file.

i, *round*, *gulleting*, *rat-tail* file.

k, *frame-saw* file.

l, *half-round* file; *nicking*, *piercing*, or *round-off* file.

m, *cross* file; *double-half-round* file.

n, *oval* file.

o, *balance-wheel* or *swing-wheel* file, the convex side only cut.

p, *swaged* file, for finishing brass-moldings.

q, *curvilinear* file.

r, *triangular*, *three-square*, or *saw* file.

s, *cant* file, for filing inside angles of 120°.

t, when parallel, *banking* or *watch-pinion* file; when taper, *knife-edge* file.

v, *screw-head*, *feather-edge*, *slitting* file.

w, *valve* file.

x, *triangular-and-half-round* file.

y, *double* or *checkering* file, for gunsmiths.

z, *double*, or *pencil-sharpening* file.

Other grades of files are known by peculiarities of form not shown by section; such as:—

Taper; thinner towards the point.

Parallel; the same dimensions throughout the length.

Blunt; a grade between taper and parallel.

As to character of teeth, the classes are:—

Double-cut; having two sets of teeth crossing obliquely.

Single-cut or *float;* having but one row of teeth.

Rasp; having detached teeth made by a punch, instead of a chisel.

A (Fig. 1965) shows the position and action of the file-chisel on the blank *B*; *C* the appearance of the rows of teeth. The lower row should, however, have been shown as not quite squarely across the face of the file.

As to relative fineness of teeth:—

Rough-cut.	Second-cut.
Middle-cut.	Smooth.
Bastard.	Superfine or dead smooth.

Approximate number of cuts in an inch of files:—

Length of File in Inches.	4.	6.	8.	12.	16.	20.
Rough . . .	56	52	44	40	28	21
Bastard . . .	76	64	56	48	44	34
Smooth . . .	112	83	72	72	64	56
Superfine . .	216	144	112	88	76	64

See any in the following list, under their alphabetical heads:—

Angular-file.	Joint-file.
Arm-file.	Key-file.
Balance-wheel file.	Knife-file.
Barrel-file.	Lock-file.
Bastard-file.	Marble-workers' file.
Blunt-file.	Middle-cut file.
Bow-file.	Molding-file.
Bread-rasp.	Nail-file.
Cabinet-file.	Nicking-file.
Cant-file.	Oval file.
Carlet.	Parallel-file.
Checkering-file.	Parting-tool.
Circular-file.	Perforated file.
Cobler.	Piercing-file.
Concavo-convex file.	Pillar-file.
Cotter-file.	Pinion-file.
Cross-file.	Pivot-file.
Cutting-file.	Pottance-file.
Dead-smooth file.	Quannet.
Dental-file.	Rasp.
Double-file.	Rasp-cutting machine.
Double-cut file.	Rasper.
Double half-round file.	Rasp. Mechanical
Double-tang file.	Rat-tail file.
Dovetail-file.	Riffler.
Entering-file.	Rough-file.
Equaling-file.	Round-file.
Feather-edge file.	Round-edge file.
File-blank.	Round-off file.
File-blanks. Rolling	Rubber-file.
File-carrier.	Safe-edge file.
File-chisel.	Saw-file.
File-cleaner.	Saw-filing machine.
File-cutting machine.	Second-cut file.
File-sharpening.	Screw-head file.
File-stripper.	Shouldering-file.
Filing-block.	Single-cut file.
Filing-machine.	Slitting-file.
Filings-separator.	Smooth-file.
Flat-file.	Square-file.
Float.	Superfine-file.
Found.	Swing-wheel file.
Graille.	Taper-file.
Half-round file.	Three-square file.
Half-thick file.	Topper-file.
Hand-file.	Triangular-file.
Hollow-edge file.	Turn-file.

Valve-file.
Verge-file.
Warding-file.
Watchmakers' file (varieties, see WATCHMAKERS' FILES).

The sculptor's file is known as a *riffler*, and is curved in various forms. Hiram Powers's file is perforated to allow escape of plaster or marble-dust.

The method of handling the chisel depends in great measure on the kind of tooth to be cut. The file is held to its place on the leaden anvil by means of a leathern strap passing over each end of the file, and then under the feet of the workman in the manner of stirrups. At every blow of the hammer the chisel is made to cut a tooth, and the blows follow each other in rapid succession, the workman after every blow advancing the chisel forward by a slight movement. The chisel forms a number of angular grooves parallel to each other, the tooth being formed by the metal raised between every two grooves. As the work proceeds, he shifts the file forward by loosening his tread upon the straps. When one surface is covered with single cuts, he proceeds, in double-cut files, to add a second row of teeth, making them cross the former obliquely.

The files are next hardened, unless they are to be used upon wood, ivory, and other soft substances; such files admit of being sharpened up with a hand-file. Some of the curved files used by sculptors and die-sinkers are made of iron and case-hardened.

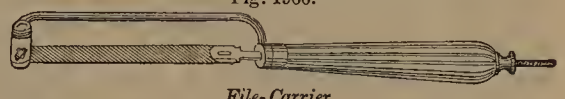
Mr. Holtzapffel describes the operation of cutting in the following terms: "The first cut is made at the point of the file; the chisel is held in the hand at a horizontal angle of about 55° with the central line of the file, as in the upper row of cuts at *C*, and with a vertical inclination of about 12° to 14° from the perpendicular, as represented at *A*." (Fig. 1965.)

"The blow of the hammer upon the chisel causes the latter to indent and slightly to drive forward the steel, thereby throwing up a trifling ridge or bur; the chisel is immediately replaced on the blank and slid from the operator, until it encounters the ridge previously thrown up, which arrests the chisel or prevents it from slipping farther back, and thereby determines the succeeding position of the chisel. The heavier the blow, the greater the ridge, and the greater the distance from the preceding cut at which the chisel is arrested. The chisel, having been placed in its second position, is again struck with the hammer, which is made to give the blows as nearly as possible of uniform strength; and the process is repeated with considerable rapidity and regularity, sixty to eighty cuts being made in one minute, until the entire length of the file has been cut with inclined, parallel, and equidistant ridges, which are collectively denominated the first course. So far as this one face is concerned, the file, if intended to be single cut, would be then ready for hardening. Most files, however, are double cut; that is, they have two series or courses of chisel cuts. In cutting the second course, the chisel is inclined vertically as before, at about 12°, but its edge only a few degrees from the transverse line of the file, or about 5° to 10° from the rectangle. The blows are now given a little less strongly, so as barely to penetrate to the bottom of the first cuts, and from the blows being lighter they throw up smaller burs, consequently the second course of cuts is somewhat finer than the first. The two series, or courses, fill the surface of the file with teeth, which are inclined towards the point of the file." See Holtzapffel's *Turning and Mechanical Manipulation*, London, 1847.

File-blank. A piece of soft steel, shaped and ground ready for cutting, to form a file.

File-car'ri-er. A tool-holder like the stock of a frame-saw, and used to mount a file in a manner similar to that of the saw in the case cited.

Fig. 1966.



File-Carrier.

File-chis'el. The cold chisel (*A*, Fig. 1965) for rough files is about 3 inches long, 2¼ wide, and the angle of the edge is about 50°. (See FILE.) The edge is straight. The file-blank rests upon a block of lead which forms the anvil. The narrower chisel, for cutting smaller and smoother files, has a length of about 2 inches, width ½ inch. It is very thin and sharpened to an angle of about 35°. It is used with a hammer weighing one or two ounces. Other chisels are of intermediate proportions. The edge is always wider than the file to be cut.

The chisel is held in the left hand at an inclination of 4° to 15° from the perpendicular, according to the character of the file.

The blow of the hammer drives forward the chisel, raising a bur, the hight of which determines the distance of the next cut, as the sliding of the chisel against the ridge previously thrown up affords a gage for the position of the chisel at the next blow, the operator being guided by the sense of touch. The cuts are made at the rate of 60 to 80 per minute. The file-blank is greased before cutting.

File-clean'er. A scratch-brush of wire. A thin brass edge which acts as a rake. A card such as is used in carding cotton.

To remove wood, dip the file in hot water to swell the wood. It is then removed by a hard brush; the warmth evaporates the moisture.

File-cut'ting Ma-chine'. A machine by which files are cut automatically. The usual form has a table to which the blank is secured, and on which it is fed beneath the chisel, which receives the blows of a trip-hammer above.

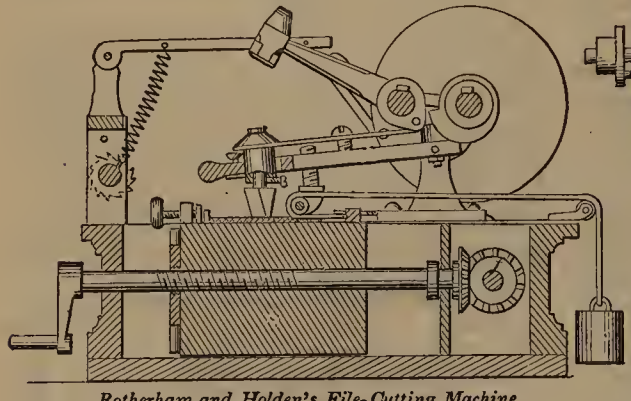
Many attempts have been made in this direction in France, England, and the United States. Among these may be mentioned Duverger, 1699; Fardouet, 1725; Thiout, 1740; Brachal and Gamain, 1756, 1778; Raoul, 1800; Ericsson, 1836; Robison, 1843. See also Skilton's machine, "Ure's Dictionary," Vol. II. pp. 202–204, edition of 1860. See also "Transactions of the American Philosophical Society," Vol. II., in which a machine is described in which the file is fixed on a bed of lead, and a chisel fixed at the end of a lever is struck down by a hammer. The lever is again raised by means of a spring, and during its rise moves a ratchet-wheel connected with the support of the bed, which is shifted, together with the file, after each stroke. In Thiout's machine ("Traité de l'Horologie," Paris, 1740), the file is attached to a screw-slide suspended at the end by pivots and covered with an anvil-plate of tin. The slide works upon a stationary anvil, and is worked by a feed-screw moved at intervals the distance of the pitch of a tooth by means of a pin-wheel. The chisel is held on a jointed arm beneath which is a spring to raise it after each blow, the latter being given by a vibrating drop-hammer. Ericsson's machine was adapted to cut several files at a time, and is especially commended for the introduction of means by which, in cutting taper files, the hammer is less raised in cutting the ends of the files than at the middle, so as to proportion the force of the blow to the width and depth of the cut at different parts of the file. Two machines were used for double-cut files, the bed of one inclined to the right and the other to the left, to give

the different horizontal inclinations proper to these teeth, and a machine with a straight bed was used for single-cut *floats*, and for round and half-round files. The machines make about 240 strokes per minute, which is about three times the rate of hand-work, and two beds are employed, so that one may be cutting while the blanks are being adjusted upon the other.

Sir John Robison, formerly president of the Royal Scottish Society of Arts, suggested, in 1843, the making of curvilinear files by cutting flat strips of steel plate and then rolling them into shape and tempering them. Cammel's improvement was to make the plate thinner towards the edges, so that it might bend equally, and not too much in the middle, as it was apt to do when of an even thickness. He also suggested to make the teeth by a graver, in an automatic machine.

Fig. 1967 shows a file-cutting machine in which

Fig. 1967.

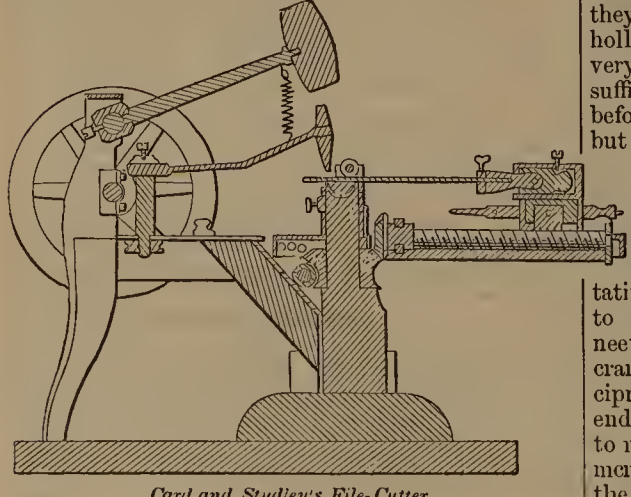


Rotherham and Holden's File-Cutting Machine.

the blanks are secured side by side on the upper surface of the bed, which is automatically fed after each stroke by the feed-screw; a separate chisel and hammer act upon each blank; the chisels are supported by springs on arms with roller feet, which bear upon the blank; the chisels are thrown back after each cut to raise a burr.

In Fig. 1968, the sliding head to which the shank of the blank is clamped is actuated by a feed-screw and half nut, the latter being automatically raised to stop the feed-motion at the proper time. The anvil has a hemispherical block, whose convex side rests in a socket of its support. The anvil and feed-

Fig. 1968.



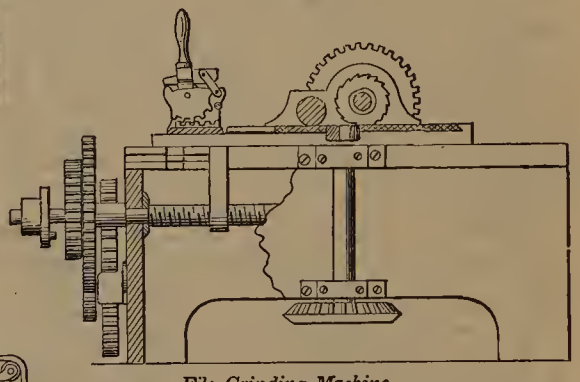
Card and Studley's File-Cutter.

movement are supported on a turn-table, by whose adjustment the inclination of the teeth is determined. The chisel is supported upon a flexible rod which is connected to the hammer-handle by a spiral spring. The hammer is attached to a rock-shaft, which has an adjustable arm acted on by a cam on the main shaft.

File-grind'ing Ma-chine'. A machine for surfacing forged or rolled file-blanks to bring them to form previous to cutting.

In the example the files are secured one after another upon a carriage which moves under a revolving cutter on a curved bed in such a manner that

Fig. 1969.



File-Grinding Machine.

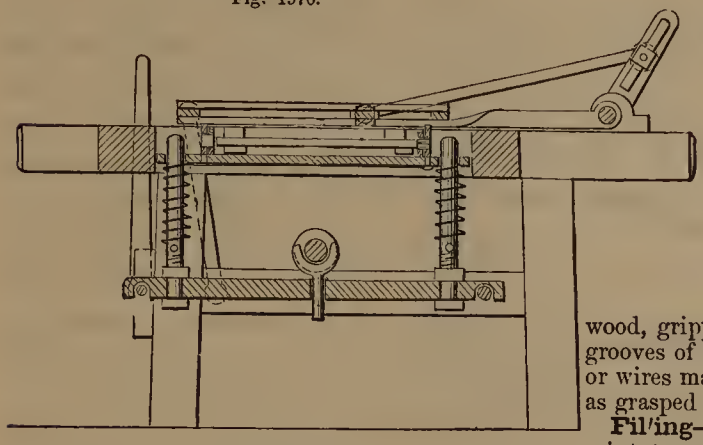
the shape of each file depends entirely upon the curvature of the bed; and as long as this curvature remains unchanged, all the files turned out upon it are uniform in shape. The files are held in position upon the carriage by a sliding clamp operated by a toothed segment. This segment connects with a hand-lever in such manner that when the clamp has been made to catch over the end of the file, the toothed segment is locked and the clamp thus prevented from spontaneously releasing the file.

Fil'er. An office device for holding bills and loose papers. See PAPER-FILE.

File-sharp'en-ing. Worn files are first cleaned by hot water and soda; then placed in connection with the positive pole of a battery, in a bath composed of forty parts of sulphuric acid, eighty parts of nitric acid, and a thousand parts of water. The negative pole is formed of a copper spiral surrounding the files, but not touching them; the coil terminates in a wire which rises towards the surface. When the files have been ten minutes in the bath they are taken out, washed, and dried, when the hollows will be found to have been attacked in a very sensible manner; but should the effect not be sufficient, they are replaced for the same period as before. Two operations are sometimes necessary, but rarely.

File-strip'per. A machine in which a worn-out file, after being softened by heat and slow cooling, is smoothed to prepare it for being re-cut. In the example, the file is held by adjustable jaws upon a slightly rotating bed supported by springs. The cross-bar, to which the stripping-tool is attached, is connected at each end by a connecting rod with a crank upon the end of the driving shaft, and is reciprocated in guides upon a frame hinged at one end to the driving-shaft, and which may be elevated to raise the stripper off the file through the instrumentality of a rock-shaft and a system of levers at the other end.

Fig. 1970.



File-Stripper.

File-tem'per-ing. The files are drawn through beer-grounds, yeast, or other adhesive fluid, and then through common salt mixed with roasted and pounded cow's hoof, the objects of which are to protect the teeth from the direct action of the fire and the oxidizing influence of the air; to afford an index of temperature, the fusion of the salt showing when the hardening heat is attained; and to lessen the tendency of the files to crack on being immersed in water. The file is held by the tang with a pair of tongs, and immersed quickly or slowly, vertically or obliquely, according to its form; that method being adopted which has been found by experience best calculated to keep the file straight. After the hardening, the tang is tempered by immersing it in molten lead; if the tang were left as the file, it would be liable to snap off during use.

The files are next scoured with scrubbing-brushes dipped into sand and water or coke-dust and water; they are next put into lime-water and left for some hours. They are then thoroughly dried at the fire, and lastly rubbed over with olive-oil containing a little turpentine.

Fil'i-gree. Delicate jewelry-work of gold or silver wire drawn flat or round. The wire is twisted by pinchers into beautiful forms, and soldered at the junctions.

The word is Italian. The original form seems to have been a wire with grains or beads, and the term now includes plaited, interlacing, or granular work in gold or silver wire worked into ornamental forms. The nations bordering on the Mediterranean excel in the art.

The filigree of India comprises various personal ornaments of gold and silver, groups of flowers, and small boxes and caskets. Their apparatus consists merely of a few small crucibles, a piece of bamboo for a blowpipe, small hammers for flattening the wire, and sets of forceps for interweaving it.

Fil'i-gree-glass. (*Glass.*) One of the kinds of ornamental glass for which Venice was formerly celebrated, and which has been recently revived.

Small filigree canes of white and other colored enamels are drawn; *whetted* off the required lengths, arranged in clusters in a cylindrical mold of the required shape, and then fused together by heat. The canes are then aggregated by flint glass at a welding heat, and the mass twisted if a spiral ornament be desired. Vases or other objects are made of ornamental masses of this glass, blown in the usual manner.

The *Venetian ball*, familiar in paper-weights, is made of waste pieces of filigree in a pocket of flint-glass.

Fil'ing-block. A block of apple, pear, or box-

Fig. 1971.

Filing-Block.

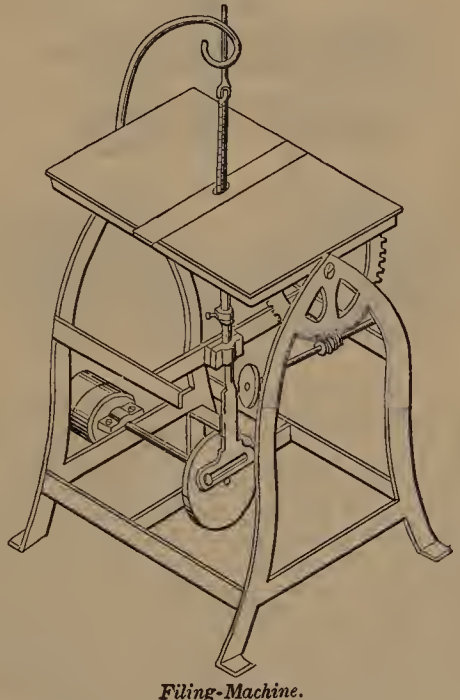
wood, gripped in the jaws of a vise, and having grooves of varying depth in which small rods, bars, or wires may be laid to be filed. The wire is shown as grasped by a hand-vise.

Fil'ing-ma-chine'. 1. A machine used in the mint to reduce the weight of coin planchets, when above the standard. The pieces are laid parallel in a trough, and their edges rest upon a cylindrical file, whereby a portion of metal is removed, the pieces rotating as the work proceeds, in order to preserve their circularity.

2. A machine in which a file is mounted as a jig-saw; or to reciprocate in a manner similar to that of a file in the hands of a workman.

In the example, the file receives vertical reciprocation from a pitman whose cross-head has a horizontal slot traversed by a crank-pin on a rotating

Fig. 1972.



Filing-Machine.

disk. The table is pivoted and has a semicircular rack which is engaged by a screw-gear to incline the table. See also SAW-FILING MACHINE.

Fil'ings-sep'a-ra'tor. A machine in which filings of iron and copper are separated by exposure to magnets which are brought into contact with all of the particles, and select, retain, and remove the iron particles from those of brass and copper, so that the latter may be used for re-melting. There are several forms of machines for the purpose.

Fil'let. 1. A strip of card-clothing. A strip of leather furnished with the bent wire teeth peculiar to carding-engines.

2. A ring on the muzzle or cascabel of a gun.

3. A ribbon of metal of gaged proportions fed to the machine which punches out the planchets for coining.

4. (*Carpentry.*) *a.* A square molding, frequently forming an upper finish or *corona*. A *band* or *listel*.

b. A strip nailed to a wall or partition to support a shelf.

c. A stop for room or closet doors to close against.

d. A strip inserted into the angle formed by two boards or surfaces.

5. (*Dairy.*) A perforated curb to confine the curds in making cheese.

6. (*Bookbinding.*) A rolling tool which has a plain line, lines, or band; differing in this respect from the ornamental rolls.

7. (*Architecture.*) The projection between the flutes of a column.

8. (*Printing.*) A rule with broad or broad and narrow lines, principally used as a border.

9. (*Gilding.*) A band of gold-leaf on a picture-frame or elsewhere.

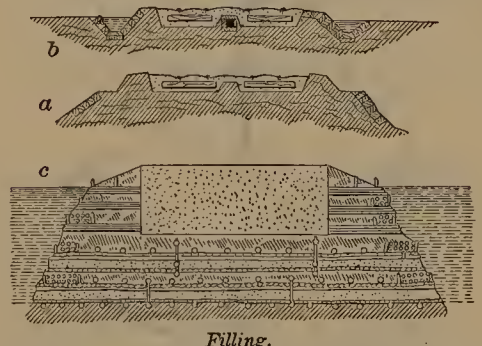
10. The thread of a screw.

Fil'let-plane. A molding-plane for dressing a fillet or square bead.

Fill'ing. 1. (*Railroading.*) An embankment of stone, gravel, earth, etc., to make a raised bed for a road, railroad track (*a*), or canal. An artificial, elevated way.

In the laying out of a permanent way, it is usual to make the *cuttings* and *fillings* counterbalance each

Fig 1973.



Filling.

other, as near as may be, but in a flat country the *way* is made by throwing the sides to the middle, making a bank bounded by two ditches (*b*). The customary soil in such situations, however, is unfit for the repose of the ties, and it becomes necessary to carry sound ballast, such as broken stone or good gravel, before the *permanent* way can be said to be in good order. Such is especially the case in ground naturally swampy. In such cases the track is either supported by piles, or, as in the annexed illustration (*c*), which represents a railroad embankment in Holland, by fascines and stakes, bound together and placed alternately across and longitudinally.

Among the largest embankments of modern times are the Tring filling of the Northwestern Railway, England, containing 1,500,000 cubic yards; the Gadelbach, on the Ulm and Augsburg Railroad, 1,750,000 yards; the Oberhäuser, on the Augsburg and Lindau Railway, 2,500,000 cubic yards.

Chat-Moss, on the Liverpool and Manchester Railway, is 4½ miles across and from 20 to 40 feet deep. Cattle could not stand upon it. To form an embankment of 277,000 yards, 670,000 yards of material were thrown into the bog.

2. (*Shipbuilding.*) Pieces or composition fitted in between the frames of the hold, to increase the water-tightness, resist compression, and prevent the collection of dirt, bilge-water, and vermin. Blocks of wood, bricks, mortar, cement, asphalte, have been used.

3. (*Nautical.*) A slip of wood forming a part of a built structure, such as a made mast; or a piece inserted to fill a defect.

The covering of a pile, below water, with broad-headed nails, to exclude the *Teredo navalis*.

4. (*Weaving.*) The *weft*-thread which fills up the *warp*, being introduced by the shuttle and beaten up by the *batten* or *lathe*. Also known as the *woof*, *shoot*, or *tram*.

5. A stopping for carious teeth. The filling of decayed teeth with gold was practiced by the Egyptians, as is proved by some mummies found at Thebes. See Dental Instruments and Appliances.

Fill'ing-en'gine. (*Silk-machinery.*) A machine in which waste and floss silk from the regular silk-machinery is disentangled, and the fibers laid parallel. The silk, previously hackled, is fed between rollers and subjected to the action of a series of moving combs. It then passes to the *drawing-frame*, where it is subjected to a farther process of substantially similar character. From the *drawing-frame* it passes to the *scutcher*, and thence to the *cutting-engine*, which cuts it into lengths of about 1¼ inches. The staple is then cleansed, dried, and eventually *carded* and *doubled*, *drawn* and *spun*, like cotton.

Fill'ing-in Pie'ces. (*Carpentry.*) Timbers occurring in partitions, groins, and roofs of less length than those with which they range; as the jack-rafters next a hip, and the short rafters filled in the side of a roof next the chimney-shaft.

Fill'ing-pile. (*Hydraulic Engineering.*) A backing or retaining pile in a coffer-dam.

Fill'ing-post. (*Architecture.*) A middle post in a wooden frame.

Fill'ing-tim'bers. (*Shipbuilding.*) Those placed between the frames to fill up.

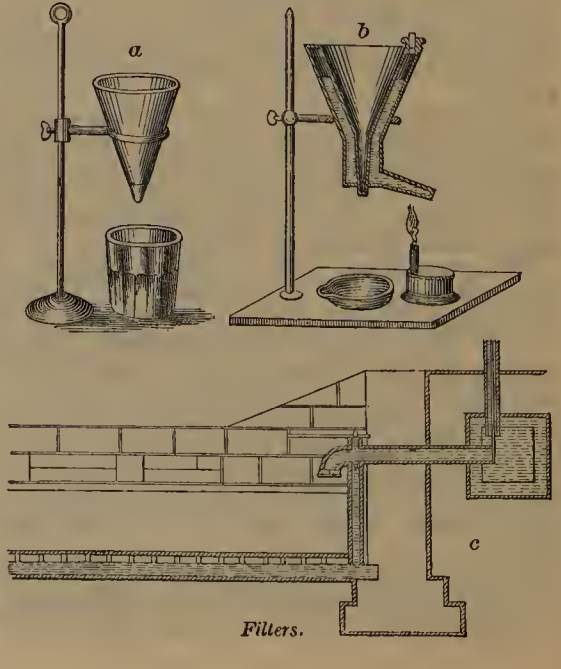
Fil'lis-ter. 1. The rabbet on the outer edge of a sash-bar, to hold the glass and the putty.

2. A plane for making a rabbet. The varieties are known as *side*-fillisters and *sash*-fillisters.

The former is regulated for depth by a movable stop. See Plane.

Fil'ter. A vessel, chamber, or reservoir through

Fig. 1974.



Filters.

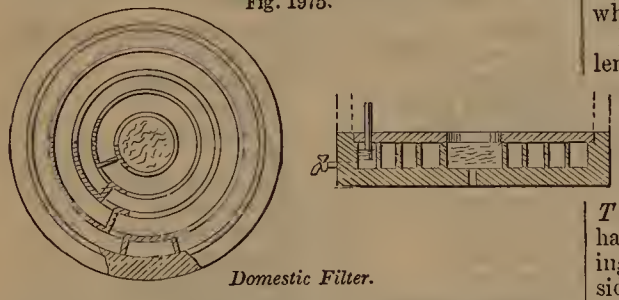
which water or other liquid is passed to arrest matters mechanically suspended therein. The idea does not necessarily include specific chemical action, though doubtless animal and vegetable charcoal have a faculty for absorbing gases and deleterious and effete matter, especially organic.

The filter (*a*, Fig. 1974) of the laboratory is made of a circle of bibulous paper, folded and opened into a quadrant and inserted into a funnel of glass or porcelain, and the filtering material is a quadrant of bibulous paper which is rolled into a cone and fitted into the funnel. Crushed and powdered glass, and gun-cotton are also used.

The filter *b* (Fig. 1974) is placed within a water bath which has a leg heated by an alcohol lamp. This is used for filtering matters which become viscid by cooling, such as gelatine, tallow, wax, stearic acid, etc. All filters for the laboratory, in which a sheet of paper is made to line a funnel and contain the liquid, should have sides subtending an angle of 60°; this for the reason that a sheet of paper folded in four, and one corner opened so as to form a cone, fills a funnel of the shape described.

The domestic filter frequently consists of a submerged jar or box made of a natural or artificial po-

Fig. 1975.

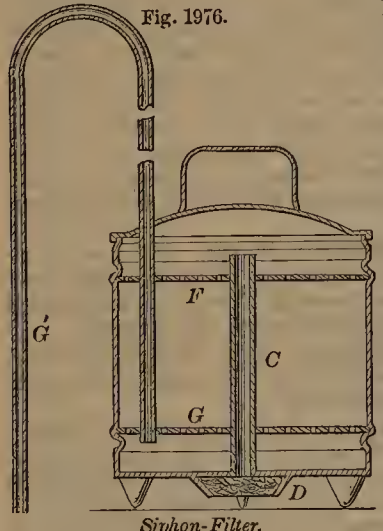


Domestic Filter.

rous stone, through which water passes, and which is withdrawn by a faucet which crosses the intervening space and passes to the outside. In another form it is a chamber at the bottom of the water-reservoir, as in Fig. 1975. The water passes down into the sponge-pocket, and thence follows around the circuitous chamber charged with filtering material to the outlet.

In another form, the filter is placed within a barrel, and the water passes through a coarse filter *D* beneath it, and up a central tube *C* to an upper chamber, and from this chamber through the filtering material contained between two perforated diaphragms *F G*. The water is drawn from the lower annular chamber by a siphon *G'* having a stop-cock at its lower end.

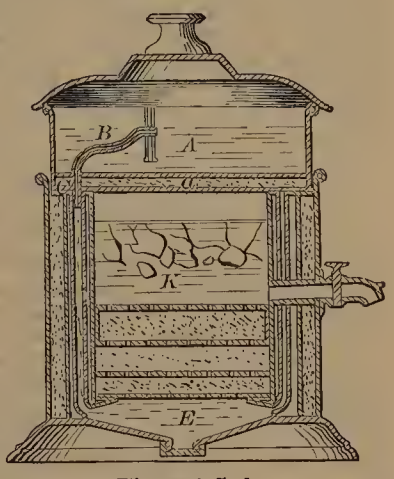
Fig. 1976.



Siphon-Filter.

A good domestic form consists of a deep wooden tub divided by a tight vertical partition through the middle, the partition at the bottom being perforated with numerous small holes. The tub is nearly filled on both sides of the partition with granulated charcoal made from sugar-maple, and screened through a mesh of one sixteenth of an inch, the fine dust being separated by bolting. The foul water enters the tub on one side at the top, passes downward and through the small holes in the partition, and rises upward on the other side, leaving its impurities, both solid and gaseous, in the charcoal.

Fig. 1977.

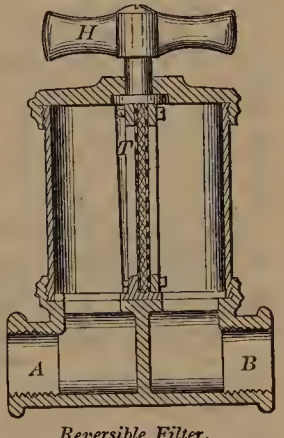


Filter and Cooler.

Fig. 1977 shows a filter and cooler combined. The water from the reservoir *A* above passes into a tube *B*, whose mouth is vertically adjustable, and is introduced below the filter-bed *E*, through which it passes upward into the ice-chamber *K*.

Fig. 1978 is a reversible filter interposed in a length of pipe. The water flowing from *A* to the filtering-surface *T* has its impurities detained, while the strained water runs off at *B*, and pursues its course along the pipe. When the filter-surface *T* has become foul, the handle *H* is turned, throwing the dirt to the delivery side, by which it is carried off, the water being allowed to run to waste until the surface is cleansed and the water runs clear.

Fig 1978.



Reversible Filter.

The filter for rain-water is a part of, or is placed at, the end of the spouting or conductor for the rain-water.

It is usually a box or chamber containing charcoal or sand, which prevents leaves, decayed wood, or other foreign matter, from passing to the cistern. It has a detachable section which intervenes between the conductor and the filter, and has a perforated strainer which arrests leaves and other larger matters which can be removed from time to time by separating the sleeve-joint coupling.

Asbestus has been used for filtering, and has this merit among others, that it may be purified readily by making it red hot.

M. Maurras's filter is a water-tight iron box 5½ feet square, with a filtering surface of 60 superficial feet, which, with a head of 12½ feet, is calculated to filter 150,000 gallons of water per diem. It percolates from the circumference inward, passing through fine and coarse sand, is received in a central chamber from whence it is discharged by a pipe. The chamber contains a number of perforated boxes containing sand which cannot pass the interstices; between these are layers of fine and coarse sand. The reversal of the current agitates the contents so as to stir up the sediment, which passes off to the waste-pipe, till the sand is cleaned. The ordinary flow is then resumed.

The mode of filtration in those of the London Water-Works, wherein this process of purification is used, is by the descent of the water, which passes through strata of fine and coarse river sand, broken shells, and pebbles, small and large gravel. These are placed in the bottom of the reservoir, so as to present an undulated surface. Below these are tunnels made of brick, built open-jointed. The sediment penetrates to a depth of from 6 to 9 inches, and that much of the surface-sand is frequently removed, portions of the area at a time. An acre of area filters 300,000 to 400,000 cubic feet daily.

A natural filter is used at Nottingham, England, the reservoir being dug in such position as to receive its water by percolation from the river through a bed of fine sand, which intervenes between the two. The sedimentary matter is continually washed away from the river face of the filter by the action of the stream.

The filter of Greenock, Scotland, is a tank 50 feet long, 12 wide, and 8 deep. The water percolates either upward or downward through the filtering material as it may be directed. After the filter has become foul, by opening a sluice the water is turned in the other direction, passing upward through the filter, and passing off by a waste-sluice. After the water is cleansed, the sluices are changed and the filter operates as before. There are three of these filters in the works.

The filter of Paisley (*c*, Fig. 1974), constructed by Thom, is upon the principle just stated. Water is admitted to the filter by opening a sluice, and runs upon the surface of the filtering material through which it percolates, and passes off by the main. The stop-cock is kept closed so long as the filter does effective duty, but when it becomes choked by sedimentary matter and mud, the stop-valve of the main is closed, the stop-cock lowered, and the water carried by a pipe *beneath* the filtering material, so that the upward pressure will dislodge the mud and carry it up through the various strata of gravel and sand.

Upon the floor of the filter bricks are laid edgeways, a little apart from each other at all points; upon these perforated tiles are laid, nearly touching. The strata of filtering material are successively, —

Gravel, about $\frac{3}{10}$ inch in diameter.

Gravel and sand, four courses of gradually increasing fineness.

Sand, fine, clean, and sharp, 2 feet deep. The upper 6 or 8 inches mixed with broken animal charcoal; say pieces $\frac{1}{16}$ inch in diameter.

When cleaning the filter bed by the upward pressure of water, the upper part of the stratum of sand is raked to dislodge the mud, which is apt to accumulate at the surface.

The filter-bed is 60 × 100 feet in area, divided into three compartments capable of separate use. It is made in a level piece of ground excavated to the depth of 6 to 8 feet, and lined on sides and bottom with a wall puddled in the rear, and laid in hydraulic cement.

The water filtered amounts to 106,632 cubic feet in twenty-four hours.

Natural filters consisting of beds of gravel or sand intervening between a pumping well and a muddy river or sea water, as the case may be, are found in many places; Dayton, Ohio, and Cape Cod may be mentioned, in addition to that at Nottingham, England, just cited.

The filter for sirups is charged with bone-black, revived from time to time by reburning to consume the absorbed organic matter. As a mere filter, cloth covered with paper pulp has been used successfully for sirups. See SUGAR-FILTER; CENTRIFUGAL-MACHINE.

The filter for separating the mucilaginous matters from vinegar is charged with wood-shavings, straw, spent tan-bark or *rapes*. The latter consists of stalks and skins of grapes from which the must has been expressed. *Rapes* are far preferable to any other material. The vinegar is passed again and again through the filter.

Air-filters are used for arresting dust, steel-filings, smoke, etc., according to circumstances and exposure. (See AIR-FILTER.) A filter recommended by Professor Tyndall consists of a cylinder four or five inches long and two inches or more in diameter. Its interior contains, at the top, a layer of cotton-wool which has been moistened with glycerine, then a layer of dry cotton-wool, then a layer of charcoal, then cotton-wool, with wire-gauze covers at both ends, and at the upper end a mouth-piece so shaped as to fit closely over the mouth of the wearer. By drawing the breath through this instrument, the most dense smoke may be entered with impunity. When places are to be entered, such as mines or wells, where carbonic-acid gas is present, it is necessary to add another layer of cotton-wool, and to place between the two bottom layers of cotton a layer of slaked lime to arrest moisture and carbonic-acid gas. See also INHALER; RESPIRATOR.

See under the following heads: —

Air-filter.
Air-pressure filter.
Bag-filter.
Bent-pipe filter.
Capillary-filter.
Centrifugal-filter.
Charcoal-filter.
Cistern-filter.
Drip-stone.
Faucet-filter.
Filter-bed.
Filtering hydrant.
Filtering-paper.
Filtering-press.
Globe-filter.
Hippocrates-sleeve.
Hydro-extractor.
Laboratory-instruments.
Oil-filter.
Petroleum-filter.
Physeter.
Pressure-filter.
Rape.
Reversible-filter.
Sponge-filter.
Stoneware-filter.
Strainer.
Sugar-drainer.
Sugar-filter.
Tube-filter.
Upward-filter.
Vacuum-filter.
Well-tube filter.

Fil'ter-bed. A settling pond whose bottom is a filter. It may consist of a reservoir 5 feet deep with a paved bottom covered with open-jointed tubular drains leading into a central conduit. The drains are covered with a layer of gravel and a top layer of sand. The water is delivered upon the surface uniformly, and the rate of subsidence is about six inches an hour. The more rapid the rate (other things being equal) the less effective is the operation. See FILTER.

Fil'ter-fau'cet. One having a chamber containing sand, sponge, or other material to arrest impurities in water.

Fil'ter-ing Ba'sin or Tank. (*Hydraulic Engineering.*) The chamber in which the water from the reservoir of water-works is received and filtered previous to entering the mains. See FILTER.

Fil'ter-ing-hy'drant. One which subjects the water from the service-pipe and main to the action of a material to arrest mud.

Fil'ter-ing-pa'per. A bibulous, unsized paper, thick and woolly in texture, used for filtering solutions in the pharmacy or laboratory. Swedish filtering-paper is thinner and of superior quality.

Fil'ter-ing-press. One in which the passage of a liquid through a body of filtering material is expedited by pressure applied thereto. A *pressure-filter*.

Fin. 1. A mark or ridge left in casting at the junction of the parts of the mold.

2. A slip inserted longitudinally into a shaft or arbor, and left projecting so as to form a guide for

an object which may slip thereon, but not rotate. A *splinc* or *feather*.

3. A tongue on the edge of a board.

Find'er. (*Optics.*) A small telescope fixed to the tube of a larger one, the axes of the two instruments being parallel. The *finder* has a larger field of view than the principal instrument, and its purpose is to find an object towards which it is desired to direct the larger telescope.

Fine-arch. (*Glass.*) The smaller fritting-furnace of a glass-house.

Fine-arts. So far as this subject is considered in this work, it may be found under the following heads: —

Albertype.
Anaglyptography.
Anastatic-printing.
Aquatint.
Autopyrography.
Autotype.
Bank-note.
Bantam-work.
Basso-rilievo.
Block-printing.
Bronzing.
Buhl.
Burin.
Bust.
Calico-printing.
Calking.
Calotype.
Calquing.
Camaieu.
Cameo.
Camera.
Canvas-stretcher.
Carbon-printing.
Cartoon.
Chalcography.
Chasing.
Chemitype.
Chiaro-oscuro.
Chromatic-printing.
Chromo-lithography.
Chromo-xylography.
Cliché.
Crystallo-engraving.
Crystallo-ceramic.
Copperplate-engraving.
Cradle.
Crayon.
Cycloidal-engine.
Dab.
Daguerreotype.
Dead-coloring.
Deadening.
Demi-relief.
Demi-tint.
Distemper.
Diamond-point.
Die-sinking.
Easel.
Electypography.
Electrotint.
Elydoric-painting.
Embossing.
Embroidery.
Enameling.
Enamel-painting.
Encaustic-painting.
Enchasing.
Engraving.
Engraving-tools.
Etching.
Flatting.
Fresco.
Galvanoglyphy.
Galvanography.
Gelatine process.
Gem-engraving.
Gilding.
Glass.
Glass-coloring.
Glass-enameling.
Glyphograph.
Glyptograph.
Graining.
'Graph (see list under this head).
Graver.
Gumming.
Hair-pencil.
Half-relief.
Hatching.
Head-rest.
Heliograph.
Heliotype.
High-relief.
Inlaying.
Intaglio.
Japanning.
Lay-figure.
Lithography.
Lithophotography.
Lithotint.
Lithotype.
Low-relief.
Marquetry.
Mat.
Maul-stick.
Medal.
Medal-machine.
Medallic-engraving.
Metallo-chrome.
Metallography.
Mezzo-relievo.
Mezzotint-engraving.
Miniature.
Monogram.
Mosaic.
Nature-printing.
Negative.
Niello.
Palette.
Paneiconograph.
Panorama.
Parian.
Parquetry.
Passe-partout.
Pastel.
Pencil.
Photogalvanograph.
Photograph.
Photograph-cutter.
Photographic-apparatus.
Photographic-camera.
Photographic-engraving.
Photographometer.
Photolithograph.
Photosculpture.
Photozincograph.
Piqué-work.
Plaster-cast.
Plate-holder.
Polychrome.
Pottery-painting.
Print-holder.
Printing-frame.
Pyrograph.
Reisner-work.
Relief.
Relief-line engraving.
Rilievo.
Scribbet.
Sculpture.
Scumbling.
Sepia.
Silhouette.
Statuary casting.
Statue.
Statuette.
Stencil.
Stereochromy.
Stereograph.
Stereoscope.
Stretcher.
Stump.
Vignette.
Wax-modeling.
Xylograph.
Xylopyrography.
Zincography.

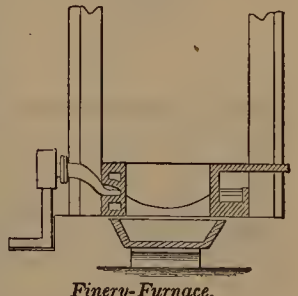
Fine-draw'ing. A finishing process with cloth in which it is subject to a strong light while all faulty parts or breaks in the fabric are closed by sound yarn introduced by a needle.

Fine-nail. A name used in some trades to distinguish a relatively thin from a coarse nail, such as a fencing nail or clout. A *finishing* nail.

Fine'ness. The quantity of pure metal in an alloy expressed in 1,000 parts; as the fineness of United States coin is 900, the other 100 being alloy.

Fin'er-y-fur'nace. A species of forge-hearth in which gray cast-iron is smelted by fuel and blast, and from which it is run into iron troughs for sudden congelation. The result is a finer quality of cast-iron of whiter color, which is subsequently puddled and made malleable. The furnace is of brick with hollow iron lining, through which water circulates. The fuel is coke or charcoal, and the melted metal is run from the crucible into a pit, where it is quenched with water to render it brittle, and perhaps oxidize it somewhat.

Fig. 1979.



Finery-Furnace.

Fine-stuff. Lump lime slaked to a paste with a moderate volume of water, and afterward diluted to the consistency of cream, and then left to harden by evaporation to the required consistency for working over a floating-coat of coarse-stuff.

In this state it is used for a *slipped-coat*, and when mixed with sand or plaster-of-paris it is used for the *finishing-coat*.

Fin'ger. 1. (*Machinery.*) *a.* A small projecting rod or wire, which is brought into contact with an object to effect or restrain a motion. The derivation of the name from the human finger is apparent, and the action is sometimes marvelously similar; as in the delicate pieces of tactile and prehensile mechanism in the stop-motions of machines working in fiber. Known as a gripper in printing-machinery.

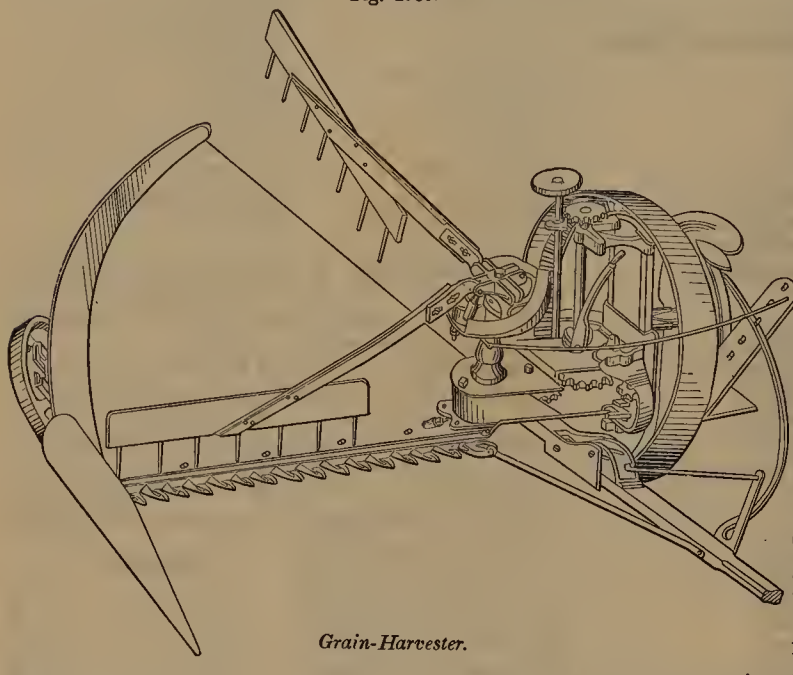
b. One of a row of similar projections, as the finger of a rake. Sometimes, as in the example, synonymous with *tooth*.

2. (*Husbandry.*) One of the projecting pieces on a finger-bar of a harvester, within and against which the knives play. See FINGER-BAR.

Fin'ger-bar. (*Agriculture.*) The bar of a reaping or mowing machine, whose front edge has pro-

jecting fingers, called *guards*, through whose horizontal slots the serrated knife reciprocates. (See GUARD.) Moving in either direction, the knife sections make a shear cut against the sharp edges of the guards, so as to sever the stalks of grain or grass which are divided either way by the guards, which hold the stalks laterally as the knives make their draw-cuts against the stems. The illustration shows the finger-bar in its relation to the quandrantal

Fig. 1980.



Grain-Harvester.

platform, revolving-rakes and driving and supporting mechanism.

Fin'ger-board. The neck of a stringed instrument of the viol, banjo, or guitar class, on which the strings are pressed by the fingers in playing.

Fin'ger-grip. (*Well-boring.*) A tool for recovering rods or tools dropped into a bored shaft. It consists of a rod having a foot which is twisted around so as to penetrate beneath the object and enable it to be lifted and withdrawn. See GRAB.

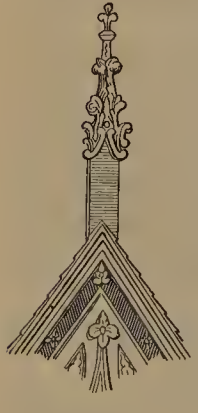
Fin'ger-nut. A nut with wings to afford a hold.

Fin'ger-plate. A plate on the side of a door, near the edge, to keep finger-marks from the paint.

Fing'roms. (*Fabric.*) Cloth made of *combed* wool.

Fin'i-al. A pointed ornament or pinnacle surmounting the apex of a Gothic gable.

Fig. 1981.



Finial.

Specifically, a bunch of foliage which terminates pinnacles, canopies, pediments, etc., in Gothic architecture.

Fin'ing. 1. Material used to add to a turbid liquid to clear it. As the isinglass or albumen subsides in the liquor, it carries down the particles mechanically suspended therein. In this way, wine, cider, sirups, and many solutions are cleared.

2. (*Metallurgy.*) Treatment of metal to remove impurities and foreign matters, as the fining (refining) of cast-iron to convert it to malleable iron by the removal of the carbon, etc.

Fin'ing-forge. (*Metallurgy.*) An open hearth with a blast by which iron is freed of impurities or foreign matters. Cast-iron is thus rendered malleable. See Fig. 1979.

Fin'ing-pot. (*Metallurgy.*) A crucible in which metals are refined.

Fin'ing-roll'er. (*Paper-making.*) A cylindrical wire-cloth sieve in the paper-making machine, which allows the finely ground stuff to pass, but restrains the coarse fibers and knots.

Fin'ings. A solution of isinglass, gelatine, or white of egg, for clarifying liquids.

Fin'ish-er. 1. (*Paper-making.*) The second *beating-engine*, or *half-stuff engine*, which operates upon the partially worked rags that have been previously reduced in the *stuff-engine* and then bleached.

2. The final carding-machine, which perfects the *fleece* or delivers the *sliver;* as distinguished from the prior machine, known as the *breaker*. A *finishing-card.*

Fin'ish-er's Press. (*Bookbinding.*) A small press, like a cutting-press, used by the finisher, who does the ornamental work on the cover.

Fin'ish-ing. 1. (*Engraving.*) The work of the graver, dry-point, and machine-ruler upon an etched plate.

2. (*Bookbinding.*) The ornamental work on a book after it is simply covered with leather or cloth, which is known as *forwarding.*

The term has many applications in the useful and ornamental arts, when a second set of workmen take up and *finish* a work which is systematically passed through a series of hands in regular order of time.

Fin'ish-ing-card. A machine in which the process of carding is repeated. The machine which first operates upon the material is known as the *breaker-card.* See CARDING-MACHINE.

Fin'ish-ing-coat. (*Plastering.*) The third coat on the better style of work. For painting, it consists of the best stuff, and is called *stucco.* For paper, it consists of the same as the previous coat, and is called *setting.*

Fin'ish-ing-ham'mer. The last hammer used by the gold-beater. The series is as follows:—

The *flat* or *enlarging hammer;* the *commencing*-hammer; the *spreading*-hammer; the *finishing*-hammer.

The latter has a more convex face than either of its predecessors; it has a face 4 inches diameter, and weighs 13 or 14 pounds. See GOLD-BEATING.

Fin'ish-ing-rolls. A second set of rolls in a rolling-mill. The first set is the *roughing-rolls*, which operate on the bloom from the tilt-hammer or squeezer and reduce it to *bar* form. This is then cut up, piled, reheated, and taken to the finishing-rolls, which make it into bar or rod iron. The reheating purifies, and the second rolling improves the tenacity by the repetition of the drawing. The finishing-rolls run at a speed two or three times greater than the roughing-rolls, according to size.

Fire-a-larm'. An automatic arrangement by which notice of fire is given. It depends for its action upon the increased temperature of the air in the vicinity of the fire, or upon the burning away

of certain connecting cords which are stretched in exposed situations.

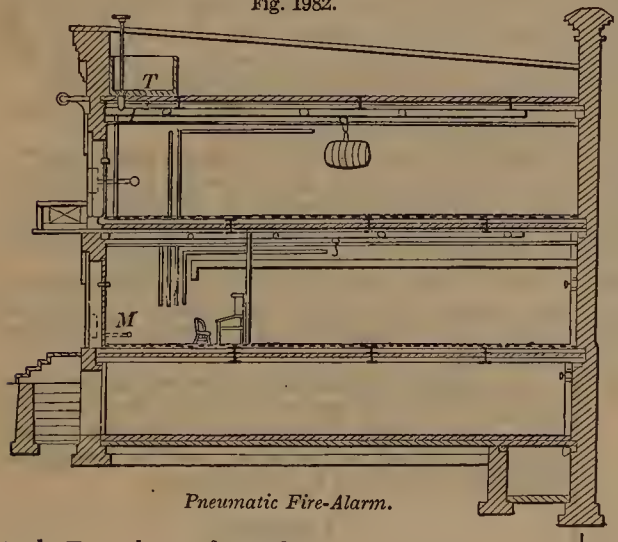
Some of these alarms are designed to give audible notice in a central situation, say at a police or fire-alarm telegraph station, the office of a warehouse or store, the bedroom of a dwelling, the cabin of a vessel. Others, in addition to the said notice, turn on a body of water to the floor whence the notice has come, or break a bottle of acid to liberate carbonic-acid gas in a reservoir of chemicals previously prepared.

a. That form of fire-alarm which depended upon the burning away of hempen springs to give the alarm, was patented in England by Joseph Smith, 1802. Cords are stretched through various rooms in the house, and connect with an alarm apparatus in the office or the bedroom of the person in charge. The cords are saturated with inflammable material, which assists in their combustion when the fire reaches them, and the breaking of either causes its alarm-weight to fall.

b. Another kind of fire-alarm has tubes throughout the building. The tubes proceed from each floor and apartment to a central office, and the occurrence of fire in either causes an expansion of air which is evidenced by a blast of air from the tube.

In the example, a farther arrangement is made, by which from the office *M* a stream of water from a

Fig. 1982.



Pneumatic Fire-Alarm.

tank *T* on the roof may be turned on to the floor when the alarm has been transmitted.

c. The increased heat of the apartment causes expansion of a body of mercury, and brings it in contact with a wire of a metal which readily amalgamates. The wire then breaks with the strain applied to it. The fracture of the wire releases the escapement of the clock-work, and the hammer strikes the alarm-bell. The same automatic agency turns a cock and admits an extinguishing agent which is kept in reserve.

d. A thermostatic arrangement by which a closure of an electric circuit is made when the metal expands under the increment of heat. The thermostat is a column of mercury, which ascends in a tube and makes the electric connection ; or a plate or coil of two metals on the principle of the chronometer-balance, or it is an elongating rod.

The connection made, an armature in the telegraphic-wire circuit is attracted by its magnet and releases a clock-work alarm.

The Tunnicliffe fire-alarm has a cylindrical barrel 3 inches long by 1½ inches in diameter, which, by a screw attached midway along its length, may be readily secured to the ceiling or any part of the room desired. It contains, when ready for use, a small charge of powder, to which is attached an inch of fuse. This fuse is formed of a chemical mixture that will ignite whenever the surrounding atmosphere is heated to 200° F. In case of fire, the heat which ascends to the ceiling quickly ignites the fuse and causes an explosion sufficiently loud to be heard all over an ordinary four-story building. The alarms can be so arranged as to ring bells in any desired room in the building where placed, and may be attached to wires connected with burglar-alarms in stores and residences.

Fire-a-larm' Tel'e-graph. The name applied to the system of telegraphy usually adopted in this country for giving notice of fires.

The first practical applications of the telegraph to this purpose were in 1851 in the cities of New York and Berlin, that in the latter under charge of one of the Siemens brothers. These systems simply connected a series of watch-towers, wherein watchmen were stationed, by an ordinary Morse line, so that the watchmen could telegraph to each other the locality of a fire.

The present system is that of Farmer and Channing, American patent of May 19, 1857.

Mr. Channing first devoted his attention to this subject in 1845, and published several articles that year attempting to show its feasibility. In 1848, Mr. M. G. Farmer invented a method of ringing bells by electricity, and in an experimental trial that year the bell in the tower of Boston City Hall was rung by an operator in New York.

In 1851, Boston appropriated money to build a fire-alarm telegraph, and early in 1852 the line was completed, put in operation, and proved a success.

That system is still in use, the improvements being in the mechanical devices for carrying it into effect.

It comprised a central station, a series of signal-boxes at suitable intervals over the city connected in one or more circuits to the central station, and a series of alarm-bells connected to the central office on another circuit.

The signal-boxes contained a circuit-breaking wheel, having upon its periphery cogs or teeth, upon which a spring, pressing, closed the circuit. These cogs or teeth and their interdental spaces were so arranged on each wheel that, when the wheel was revolved by hand, the circuit was made and broken, to indicate the number given to the box making the signal. This number, being received at a central station, was immediately transmitted on the bell-circuit, bells being struck so as to indicate the box from which the alarm originated.

In the original boxes the circuit-wheel was turned by hand ; in the later boxes the wheel is turned by clock-work driven by a spring. In lieu of an operator at the central station, a repeater is there used, the alarm from the box-circuit being automatically repeated thereby upon the bell-circuit. Sometimes the bells and boxes are united in one circuit, so that from a box the general alarm is directly given. These modifications constitute what is known as the "Farmer and Channing improved" or "automatic system," from the fact that no operators at all are necessary, the turning in of an alarm at any station setting in motion all the machinery of the system.

William B. Watkins, in his patents of January 31, 1871, has extended the system so that fire or the operations of burglars automatically give an alarm at a

central station. In each house (and each room, if desired) thermostats, composed of metallic strips, are so arranged as to close the circuit of a local line upon a certain elevation of temperature, expanding the strips. Such closing actuates a local magnet, whose armature releases a detent of the signal-box mechanism, allowing the signal-box in main circuit to send in the alarm. On the same local circuit are also arranged burglar-detectors, so that a door or window being opened closes the local circuit with the same result.

Fire-an-ni'hi-la'tor. Invented by Phillips in 1849. A vessel is charged with a mixture of dried ferro-cyanide of potassium, sugar, and chlorate of potassa. It is set in action by a blow on a glass bottle which contains sulphuric acid, which flows over the charge and liberates gas which is emitted at a nozzle and expended upon a fire to quench it. See FIRE-EXTINGUISHER.

Fire-arm. A weapon which projects a missile by the explosion of gunpowder. It succeeded the long and cross bows, but the periods of the two weapons in Europe lapped upon each other. (See ARROW; BOW.) The bow and arrow are yet used by millions in Asia, Africa, and America, but the owners are always glad to trade for muskets and rifles.

The first fire-arms were doubtless rockets, in which the force of the explosion carried the tube. To these probably succeeded something of the nature of the fire-works known as Roman candles, in which pellets are loaded into a tube and fired by a match at the tube-mouth. The tubes were of bamboo, paper, or cloth, probably each of these, according to circumstances. (For early notices, see GUNPOWDER.) The cracker was used as a grenade anciently in China, and in the 8th century by the Greeks.

The first fire-arms used in Europe were cannon. (See ARTILLERY; CANNON.) Fire-arms to be carried by the soldier were a later invention. The *arquebus* was used in 1480. The musket by Charles V. in 1540. These used matches or match-locks. The wheel-lock was invented 1517; the flint-lock about 1692. The percussion principle by the Rev. Mr. Forsythe, in 1807. See GUN-LOCK.

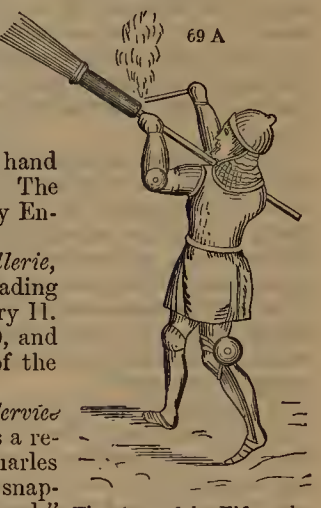
For varieties, see under the following heads: —

Accelerator.	Gatling-gun.
Armstrong-gun.	Gun.
Arquebus.	Howitzer.
Barbette-gun.	Jingal.
Battery-gun.	Lancaster-gun.
Birding-piece.	Magazine fire-arm.
Blunderbuss.	Mitrailleur.
Bombard.	Mortar.
Breech-loader.	Musket.
Byssa.	Musketoon.
Calabass.	Needle-gun.
Cannon.	Ordnance.
Carbine.	Parrot-gun.
Carronade.	Pistol.
Casemate-gun.	Pistol-carbine.
Chassepot-gun.	Pivot-gun.
Cochorn.	Repeating fire-arm.
Columbiad.	Revolver.
Culverin.	Rifle.
Dahlgren-gun.	Shot-gun.
Double-barreled gun.	Shunt-gun.
Enfield-rifle.	Siege-gun.
Eprouvette.	Small-arm.
Field-gun.	Swivel-gun.
Fowling-piece.	Tinker.
Fusil.	Whitworth-gun.

This article treats of breech-loading small-arms generally; *magazine fire-arms*, *needle-guns*, *revolvers*, *pistols*, *cannon*, and *battery-guns* are also considered under their respective heads.

"It was in 1430," says Biblius, "that small-arms were contrived by the Lucquese, when they were besieged by the Florentines." A French translation of Quintius Curtius, preserved in the British Museum, has the earliest illustration of hand fire-arms yet discovered. The cut is from the "Penny Encyclopædia."

Fig. 1983.



Fire-Arm of the Fifteenth Century.

In the *Musée d'Artillerie*, Paris, is a breech-loading arm of the time of Henry II. of France, prior to 1550, and a match-lock revolver of the same period.

In the *United Service Museum*, of London, is a revolver of the time of Charles I. It is called "a snaphaunce self-loading petronel." It has a revolving cylinder containing seven chambers with touch-holes. The action of lifting the hammer causes the cylinder to revolve, and a fresh chamber is brought into connection with the barrel. Six of the seven chambers are exposed to view, and the charges are inserted without the aid of a ramrod.

Speaking generally, the early hand-guns were breech-loaders. See REVOLVER.

Abraham Hall's English patent, 1664, had "a hole at the upper end of the breech to receive the charge, which hole is opened or stopped by a piece of iron or steel that lies along the side of the piece, and movable by a ready and easy motion."

Henry VIII. took much interest in fire-arms, and two weapons, yet extant, manufactured during his reign, were substantially the same as the modern Snider rifle.

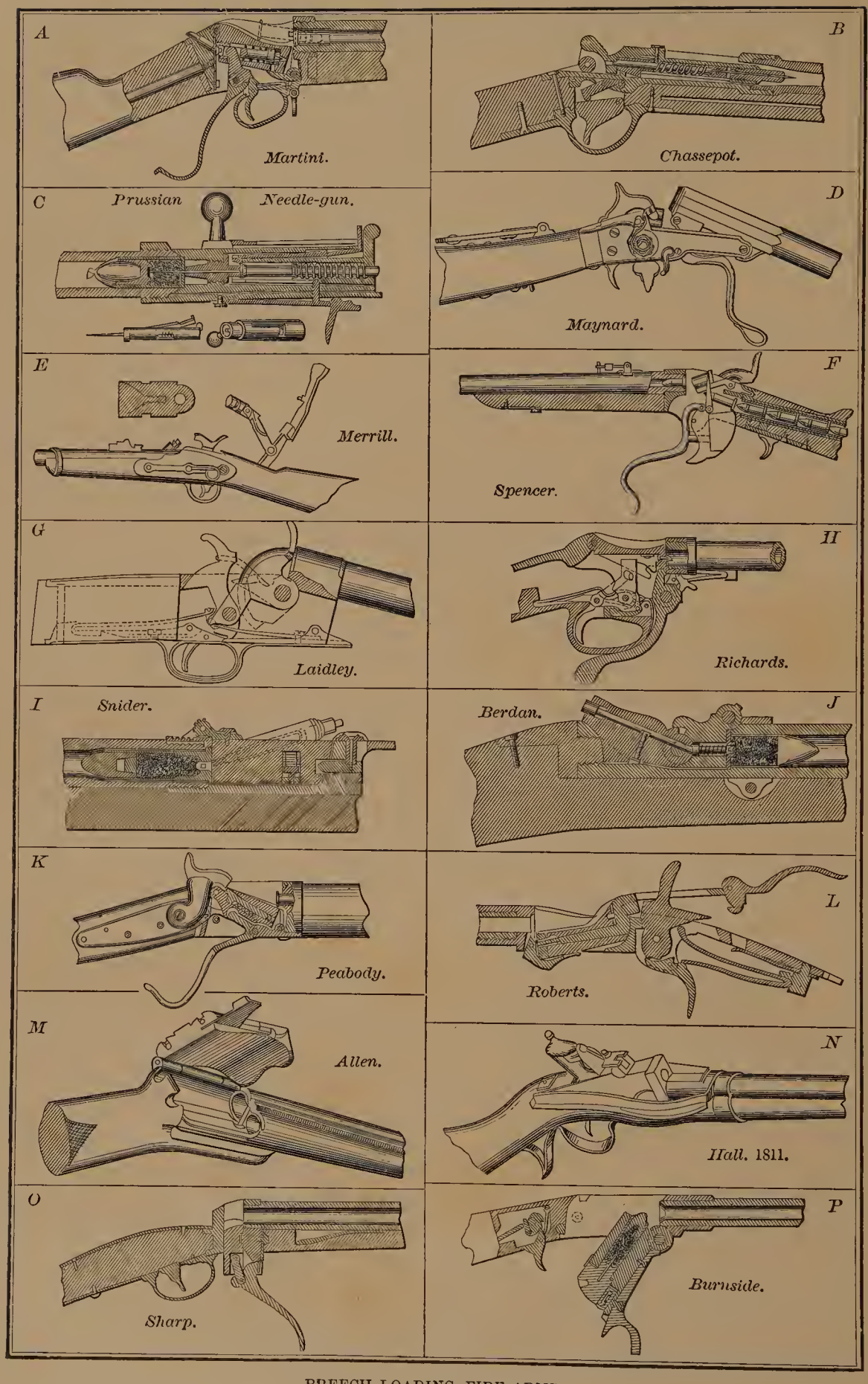
Among the curiosities of this branch of invention is Puckle's English patent, No. 418, May 15, 1718. The accompanying illustration is from the original drawing attached to the patent, and the description following is that filed by the inventor.

"A DEFENCE.

Defending KING GEORGE, *your* COUNTRY *and* LAWES
Is defending YOURSELVES *and* PROTESTANT CAUSE.

A Portable Gun or Machine, called a Defence. For Bridges, Breaches, Lines, and Passes, Ships, Boats, Houses, and other Places.

No. 1. The barrel of the gun.
2. The sett of chambers charg'd put on ready for fireing.
3. The screw upon which every sett of chambers play off and on.
4. A sett of chambers ready charg'd to be slip'd on when the first sett are pull'd off to be re-charg'd.
5. The crane to rise fall and turn the gun round.
6. The curb to level and fix the guns.
7. The screw to rise and fall it.
8. The screw to take out the crane when the gun with the trepeid is to be folded up.
9. The trepeid whereon it plays.
10. The chain to prevent the trepeids extending too far out.
11. The hooks to fix the trepeid, and unhook when the same is folded up in order to be carried with the gun upon a man's shoulder.



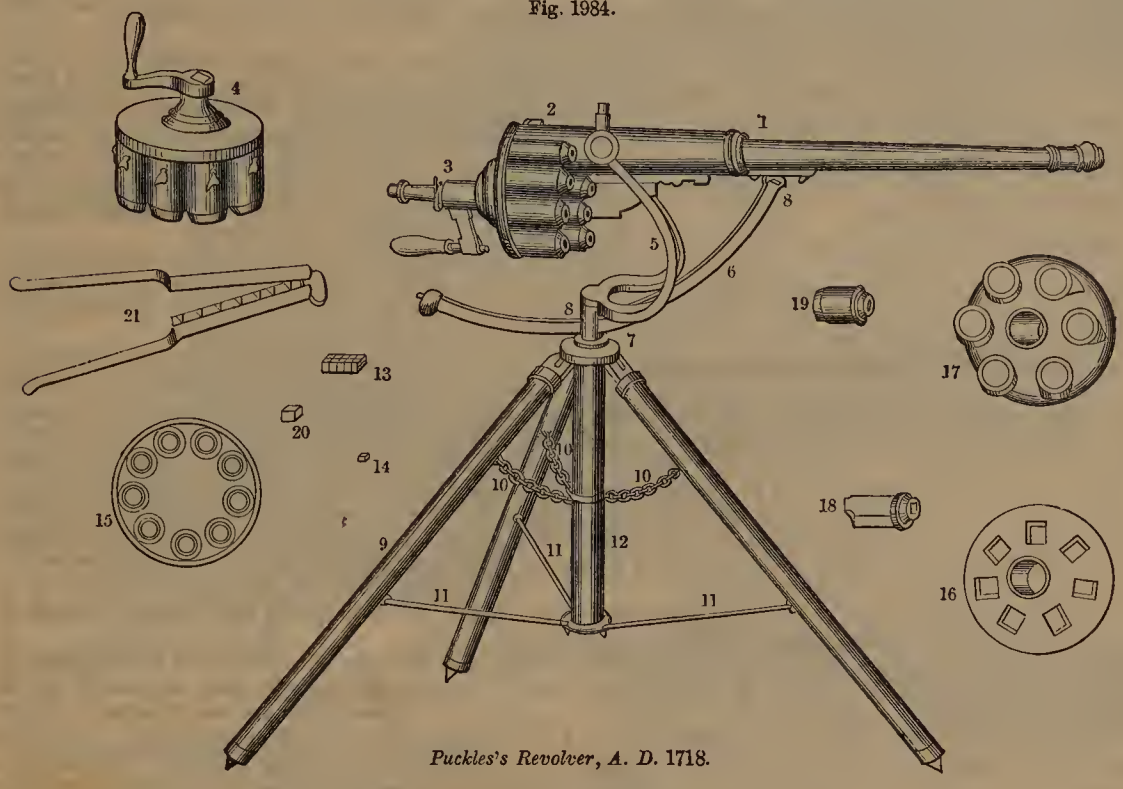
BREECH-LOADING FIRE-ARMS.

(*American and European.*)

PLATE XVI.

See page 851.

Fig. 1984.



Puckles's Revolver, A. D. 1718.

No. 12. The tube wherein the pivot of the crane turns.
13. A charge of twenty square bullets.
14. A single bullet.
15. The front of the chambers of a gun for a boat.
16. The plate of the chambers for a gun for a ship, shooting square bullets against Turks.
17. For round bullets against Christians.
18. A single square chamber.
19. A single round chamber.
20. A single bullet for a boat.
21. The mold for casting single bullets."

The parts of a gun are : —

Ante-chamber ; the cavity which connects the hollow of the nipple with the chamber in the breech.

Barrel ; the tube out of which the load is discharged.

Bead ; the silver knob for sighting on the end of the barrel.

Bolt ; the sliding piece which secures the barrel to the stock.

Breech ; the piece containing the chamber which screws into the barrel.

Butt ; the broad end of the stock which is placed to the shoulder.

Cap ; the brass tube which incloses the worm of the ramrod.

Chamber ; the cavity of the breech in which the powder is deposited and exploded.

False-breech ; the iron piece on the gun-stock which receives the breech-claws, and assists in holding the barrel firmly to the stock.

Guard ; the metallic scroll which defends the triggers.

Heel-plate ; the plate on the butt.

Lock ; the piece of many parts by which the gun is fired. See GUN-LOCK.

Loop ; the clasp on the barrel through which the bolt passes and secures it to the stock.

Nipple ; the tube on which the cap is placed, and through which the powder reaches the charge.

Nipple or *cone wrench ;* a small turning tool for securing or loosening the nipple, to and from the barrel.

Pipes ; short tubes which hold the ramrod to the barrel.

Rib (upper and under) ; the center-piece which unites the barrels.

Side-nail ; the screw which fastens the lock to the barrel.

Sight (breech and muzzle) ; an object or depression on the breech, a bead or knob on the muzzle, by bringing which into line with the object the line of fire is directed.

Trigger-plate ; the iron plate in which the triggers work.

Worm ; the screw at the end of the ramrod.

Of the gun-lock the parts are the

Bridle.	Sear-spring.
Chain, or swivel.	Spring-cramp.
Cock, or hammer.	Trigger.
Lock-plate.	Tumbler.
Main-spring.	Tumbler-screw.
Sear.	See GUN-LOCK.

The first patent in the United States for a breech-loading fire-arm was to Thornton and Hall of North Yarmouth, Mass., May 21, 1811. Between that time and 1839 more than 10,000 of these arms were made and were issued to the troops in garrison and on the frontier. This gun is represented at *N*, Plate 16, and had a breech-block, which was hinged on an axial pin at the rear, and tipped upwardly at front to expose the front end of the charge-chamber. The flint-lock and powder-pan were attached to the vibrating breech-block. The arm is shown and described in detail in General Norton's "American Breech-Loading Small-Arms," New York, 1872.

Before the war of 1861 - 65, the principal breech-loading small-arms were Sharps's, Burnside's, Maynard's, Merrill's, and Spencer's.

Sharps's rifle (*O*, Plate 16) has the barrel rigidly attached to the stock, the rear being opened or closed by a vertically sliding breech-block, which slides up and down in a mortise operated by the trigger-guard, which is pivoted at the front end, or by a lever.

The primer consists of small pellets of fulminate inclosed in a copper casing so as to be water-proof. These are placed in a pile in a hole in the lock-plate, forced upward by a spiral spring, the upper one fed forward by a plunger, caught by the cup of the hammer, and carried down upon the nipple. The cartridge is in cloth, the end covered with tissue-paper saturated with saltpeter, through which the fulminate will ignite the powder.

Burnside's rifle (*P*) has the barrel attached to the stock, the breech-piece being pivoted beneath the barrel, so as to swing downward and expose the chamber in the front end of the breech-piece for the insertion of the cartridge.

In Maynard's rifle (*D*) the barrel is pivoted to the front end of the stock, and its rear end tips upwardly, exposing the chamber for the cartridge, when the barrel is tipped down against a solid breech-piece and locked. The Maynard primer consists of pellets of fulminate placed at regular intervals between narrow strips of paper. This is coiled in a chamber in the lock-plate, and is fed forward by a wheel operated by a hammer, so as to bring a pellet on top of the nipple at each discharge.

The Merrill gun (*E*) was constructed for a paper cartridge. The breech was closed by a sliding plug locked in place by a combination of levers. The charge was exploded by a copper cap, placed upon the nipple in the ordinary manner.

The Spencer rifle (*F*) is both a magazine and a single breech-loader, seven cartridges being placed in a magazine in the but, and being thrown forward to the chamber as required. The breech-block is a sector pivoted beneath the level of the barrel, and retreating backward and downward to expose the rear of the bore for the insertion of the cartridge. The trigger-guard forms the lever for moving the breech-block.

The Roberts gun (*L*) has a breech-block pivoted at the rear, operated by a lever which extends backwardly over the small of the stock; the forward end of the breech-block being depressed, the center of its motion and its abutment in firing being a concave solid base centering on the exact prolongation of the axis of the barrel. The breech parts are four in number, articulated without pins or screws. The firing-pin passes centrally through the breech-block, and is driven forward on the center of the cartridge by a blow of the hammer.

The Martini gun (*A*) is the invention of a Swiss. The breech-block is pivoted at its upper rear portion, being moved up and down by a lever at the rear of the trigger-guard. The firing is by a spiral spring, which actuates a firing-pin. The cartridge-shell extractor works on a pivot below and behind, the barrel being operated by the descent of the front end of the breech-block upon one arm of the bell-crank lever.

The Chassepot gun (*B*) is the French arm, and is named after its inventor. It is what we term a bolt-gun, an opening on the right hand of the chamber admitting the insertion of the cartridge. The forward thrust of a knob drives the cartridge into the breech, and a partial rotation of the knob locks the breech-piece. The firing is by a needle.

The Prussian needle-gun (*C*) is also a bolt-gun, having an inner bolt which forms the firing-pin, a sleeve around it, and an outer cylinder. The parts are shown with the needle in its fired position. In preparing to reload, the rear knob is withdrawn, and the axial bolt retained by a catch which engages a projection, withdrawing the needle. The chamber is then unlocked by the knob and slid back, the cartridge inserted and driven into the breech by the chamber, which is locked by a partial rotation. The firing is done by releasing the needle-bolt.

The Laidley gun (*G*) has a breech-block pivoted beneath the barrel and rotating backward and downward to open the chamber. When in position for firing, it is fastened by a locking-brace which is operated by a spring, and vibrates on the same axis as the hammer. The breech-block is unlocked by a cam and thrown back by a pawl attached to the locking-brace and actuated by the hammer.

The Westley-Richards gun (*H*) is an English arm having a pivoted breech-block whose front end is depressed by the action of a lever pivoted to the stock beneath the rear of the barrel.

The Snider gun (*I*), built at Enfield, England, is similar to our Springfield converted rifle, of which presently. The breech-block is hinged to the rear of and above the barrel, the block throwing upward and forward, exposing a chamber in rear of the bore. Into this the cartridge is dropped, pushed into the bore, the block brought down and locked by a latch in the rear. The firing-pin passes obliquely through the block and is struck by the ordinary hammer.

The Berdan form of this type is shown at *J*, and has a breech-block in two sections hinged together.

K is the Peabody gun, which has a falling breech-block, hinged at the rear and depressed by the guard-lever, whose short arm engages in a recess of the block and controls its movements. When the block is down, the cartridge is slipped into the bore, and the piece is fired by the fall of the hammer upon a firing-pin sliding in a groove in the side of the block. In opening to reload, the block drops upon an elbow lever and withdraws the spent cartridge-shell.

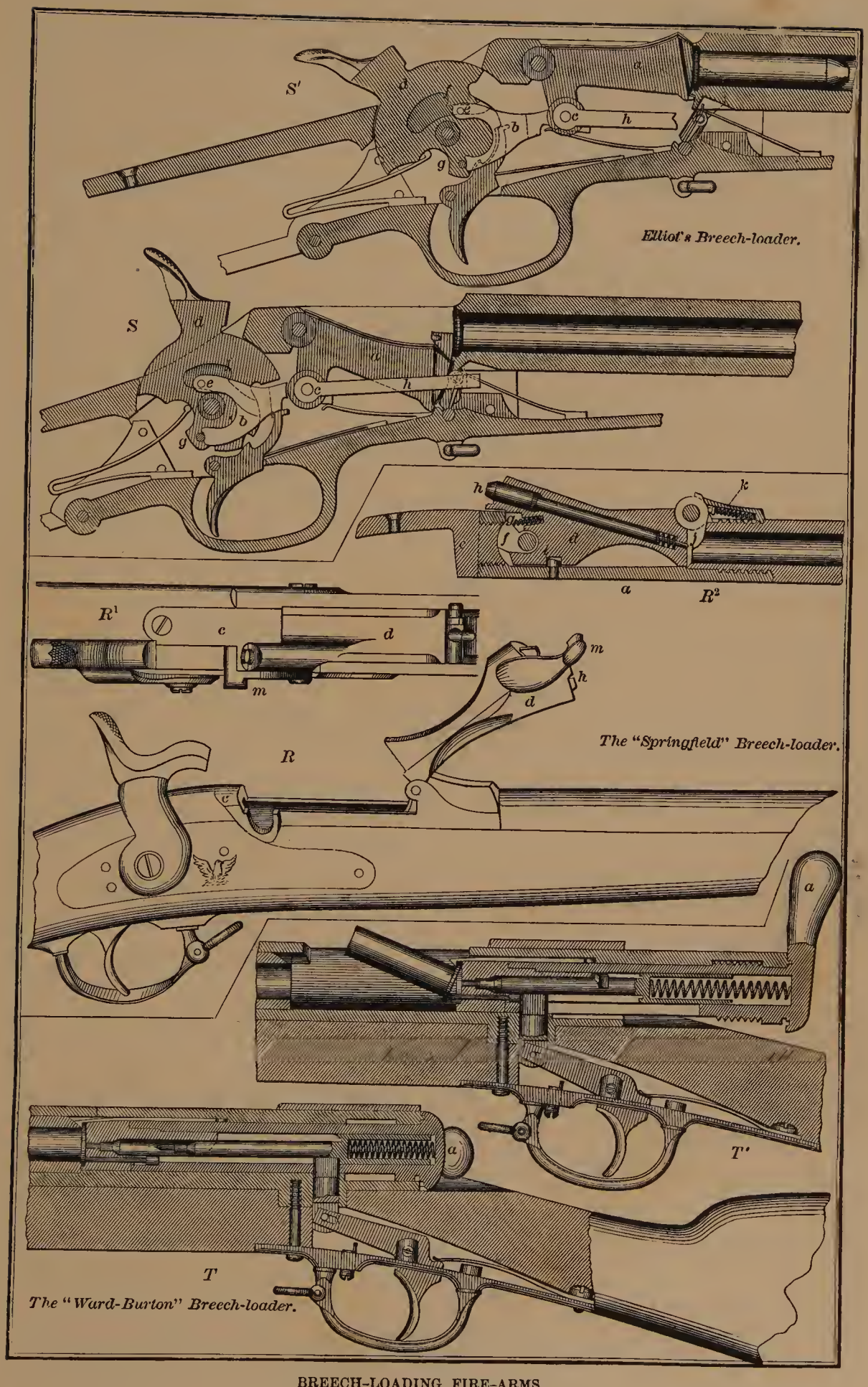
Allen's gun (*M*) is double-barreled, and the breech-block is hinged at the side, swinging upwardly and laterally. It carries both firing-pins, and is locked shut by a latch.

Plate 17 gives views of the three arms recommended this year (1873) by the army commission at Springfield.

R is the Springfield arm, having a breech-block hinged to the upper edge of the barrel and swinging upward and forward. The indorsement of the board, as the best all things considered, entitles it to an honorable place in the series of examples. *R* is a side view of the gun, with the breech-block *d* thrown up; *a* is the bottom of the receiver, *c* the breech-pin, with its circular recess to receive the cam-latch *f*, which locks the breech-block in place; *g* is the cam-latch spring, *h* is the firing-pin, which transmits the blow of the hammer to the priming of the cartridge, and is pressed back by a spiral spring after the delivery of the blow; *j* is the cartridge-shell ejector, *k* its spring; *l* an incline which tips up the ejected shell so as to throw it out of the receiver.

R' is a top view of the gun with block closed. R^2 is a longitudinal vertical section with the breech-block closed. The dotted lines show the block raised.

The breech-block is raised upward and forward in the act of opening by a thumb-piece *m*, which releases it by turning up the cam-latch out of its recess in the breech-pin. When fully open, it discloses the chamber, or rear end of the barrel, ready for the insertion of the charge contained in a copper cartridge-case, holding seventy grains of musket-powder, and firing a bullet $\frac{45}{100}$ of an inch in diameter and weighing about 400 grains. When the breech-block is closed, it is held down and braced against the effort of the heaviest charges by the cam-latch, which flies



BREECH-LOADING FIRE-ARMS.

PLATE XVII. *(Recommended by the United States Board, 1873.)*

See page 852.

BREECH-LOADING FIRE-ARMS.

(*American and Swiss.*)

PLATE XVIII.

See page 853.

into place in closing. The piece is fired by the ordinary side-lock taken from the old muzzle-loaders. In opening the piece after firing, the breech-block strikes the lump on top of the extractor, and revolves it so as to carry the now empty cartridge-shell to the rear. After passing a certain point, the spiral spring in front of the extractor is released, and accelerates its motion, so that the cartridge is thrown sharply against the beveled surface of the ejector-stud, by which it is deflected upward and expelled from the gun.

S S' are two views of the Elliot carbine recommended by the same board for trial in the field, as exhibiting "remarkable facility of manipulation in requiring but one hand to work it." This arm has a breech-block hinged to the breech-pin and operated by the hammer. Fig. *S* shows the gun in loading position, and *S'* in the position "ready to fire." After firing, the hammer *d* is pulled back to the position shown in *S*, and in so doing draws by the yoke *b* upon the breech-block *a*, to which it is pivoted at *c*. This pulls down the front end of the breech-block, exposing the rear of the barrel for the insertion of the cartridge. Having done this work, the pin *e* of the yoke slips out of the socket *f* into the lower portion of the groove, while the lower branch of the yoke engages over the pin *g*, so that when the hammer is again pulled back, the breech-block is pushed up again into the position shown at *S'*, where the hammer is on full cock and the arm ready to fire. *h* is a strap which works the retractor, so that the shell is ejected as the breech-block is pulled down. *S* shows the cartridge-ejector pulled out; *S'* shows it in its bed. One pull on the hammer depresses the breech-block and ejects the empty shell; another pull closes the breech-block and puts the hammer in position for firing; a pull on the trigger fires the arm.

T T' are two positions of the Ward-Burton gun, which is on the *bolt* principle, like the Prussian needle-gun and the French Chassepot. This gun, in its magazine form, was also recommended "for farther trial in the field." This gun, having been fired, is opened by raising the handle *a* of the bolt and withdrawing it directly rearward; the position is shown in Fig. *T'* of Plate 17. As the cartridge-shell is pulled out by the spring-hook on the upper edge of its flanged rim, the pin which rests against its lower portion comes in contact with the front end of the trigger-pin, which tips it up and throws it out of the receiver. Another cartridge is then introduced by hand or by automatic devices from the magazine, and pushed into the bore of the gun by the longitudinal forward motion of the bolt. Near the head of the bolt is seen a part of the sectional screw which engages with a corresponding section within the gun when the piece is closed, and the handle turned down into place, so as to support the bolt against the force of the discharge. The firing-pin is an axial spring-pin released from the bolt by a downward pull by means of the trigger and lever. Fig. *T* is the position "ready to fire," the driving-spring being condensed and ready to act. Fig. *T'* shows the bolt withdrawn and the cartridge tumbling out. When the bolt is withdrawn, the sleeve of the firing-pin is so far retracted that a shoulder catches behind the trigger. When the bolt is pushed home, driving the cartridge into the barrel, it leaves the shoulder of the firing-pin resting against the trigger, as shown in Fig. *T*.

Plate 18 shows three other American forms of fire-arms, and the Swiss adopted pattern, which is a bolt needle-gun.

U U' are two positions of the Remmington gun; the left-hand figure is "fired," the right-hand "ready to load." The breech-block *b* swings upon a strong pin within a mortise of the stock. *c* is a tumbler which braces the breech-piece against recoil at the time of firing, and forms a part of the hammer which strikes a firing-pin, which passes through the tumbler and is driven against the cap or part of the cartridge-case containing the fulminate.

The breech-piece *b* and tumbler *c* are so formed that when the former is closed the rounded upper portion of the tumbler works in a concavity in the back of the breech-piece, as shown in Fig. *U*, and when the hammer is drawn back to half-cock or full-cock the rounded back of the breech-piece works in a concavity in the front of the tumbler, as shown in Fig. *U'*. This mode of matching the breech-piece and tumbler prevents the possibility of the hammer falling until the breech-piece is perfectly closed, and so obviates the possibility of premature explosion of the charge. The extractor, by which the discharged cartridge-shells are drawn out from the chamber of the barrel, works between the receiver and the breech-piece, and is operated by the opening movement of the latter. The breech-piece is opened by the thumb-piece. A guard-lever *d* prevents the trigger being drawn when the breech-piece is open.

W W' are two views of the Dodge breech-loader, shown as a double-barreled breech-loading fowling-piece. *W* is a perspective view, and *W'* a sectional view. The barrels are hinged to the front end of the stock, so as to tilt upwardly at the rear and nearly balance upon the hinging-point; the motions being made by means of the pivoted lever *d*, which laps over the trigger-guard and locks the barrels in firing position by engagement of a hook *c* with a pin passing through the lug *g*. The front end of the lever extends beyond the pin on which it turns, and works in a slot in the center of lug *g* beneath the barrels, which it serves to elevate and depress. As the barrels are elevated, the front end of the lever strikes against a projection on the stem of the extractor, and retracts the spent cartridge capsule. The frame *e* is made of a single piece of metal extending from the front, where the barrels are hinged, to the grip in the rear of the breech; and the locks are fitted in recesses therein, dispensing with separate lock-plates. The locks are "rebounding," that is, they go forward and fire the cap and return to half-cock. The hammers draw back the firing-pin when full-cocked. The barrels are adjusted on the frame, and wear is compensated by means of the block *b*. In use, the left hand need not be moved from where it is in firing; the breech is brought under the right arm, the lever thrown down, fresh cartridge inserted, the lever returned, the hammer cocked, and the piece is ready to fire.

The gun adopted by the Swiss Federal government has the magazine and cartridge-carrier of the Winchester, with the needle-exploder and bolt breech. The large figure is a longitudinal central section; *x* is a perspective view of the bolt, firing-pin, and lever detached; x^1 is a view of a piece of the breech-cylinder; x^2 is a view of the cartridge-carrier detached. The motions are as follows: the lever *a* is raised, rotating on the firing-pin *b*, and cocking the latter by the pressure of a cam upon the transverse trigger-bar *c*; the bolt is then drawn back, carrying the firing-pin and the hook, which retracts the spent cartridge; the motion eventually rocks the bell-crank lever *d* and raises the carrier *e*, which brings another cartridge in line with the barrel. The bolt *h* is then pushed back, pressing down the carrier *e* and driving the cartridge into the barrel; a partial rotation of

the bolt, by means of the lever *a*, locks it firmly by the catching of studs *f* on the bolt behind lugs *g* on the breech-cylinder. The firing-pin has remained on cock since the first motion of semi-rotation of the bolt, and is now pulled off by the trigger. The combination is known as Vetterlin's.

Y' is the Henry magazine rifle, now known as the Winchester repeating-gun. It may be used as a single-loader or a repeater. As a repeater, the motion of the lever *a* withdraws the spent shell of the previous charge, raises the hammer, recharges the gun, and relocks the breech mechanism. The magazine contains seventeen cartridges, which can be discharged in as many seconds. With single loading, the cartridge is placed in the carrier-block, and a single motion puts it in order for firing. The cartridges are placed in the magazine by pressing them through the trap *b* on the right-hand side of the gun, the magazine being easily filled while the gun swings at the side. They are fed from the magazine into the carrier-block by a spiral spring.

Y is a section of the gun immediately after discharge; *e* is an empty shell; *d* one in the carrier-block; *e*, one in the magazine; by the forward motion of the lever *a* the links take the position shown in *Y'*, the piston *g* is withdrawn, raising the hammer to the full-cock, and extracting the empty shell *e*, which is thrown upward at the same time the carrier-block *h* with the carriage which it contains is raised by the lever *i* placing the cartridge opposite the chamber. This position is seen at *Y'*. The returning motion of the lever drives the piston forward, leaves the hammer at full-cock, forces the cartridge contained in the carrier-block into the chamber, drops the carrier-block to receive the following cartridge from the magazine, and places the arm in readiness to be fired.

The United States has adopted the Springfield.

England adopts Snider's improvement on the Enfield.

France, the Chassepot.

Belgium, the Albini.

Holland, the Snider.

Turkey, the Remington and Winchester.

Austria, the Wanzl.

Sweden, the Hägstrom.

Russia, the Laidley and Berdan.

Switzerland, the Winchester.

Portugal, the Westley-Richards.

Prussia, the needle-gun. The well-known form shown at *C*, Plate 14, has been superseded by the *Mauser* gun. See NEEDLE-GUN.

The breech-loaders purchased by the American government between January 1, 1861, and January 30, 1866, were of number and kind as follows: —

Ballard	1,500	Maynard	20,002
Ball	1,002	Palmer	1,001
Burnside,	55,567	Remington	20,000
Cosmopolitan	9,342	Sharps	80,512
Gallagher	22,728	Smith	30,062
Gibbs	1,052	Spencer	94,156
Hall	3,520	Starr	25,603
Joslyn	11,261	Warner	4,001
Lindner	892	Wesson	151
Merrill	14,495		

CLASSIFICATION OF BREECH-LOADING FIRE-ARMS PATENTED IN THE UNITED STATES.

Class A. Movement of Barrel.

1. *Sliding longitudinally forward.*
2. *Tilting*
   - (*a.*) Down at muzzle and up at breech.
   - (*b.*) With muzzle upward.
   - (*c.*) On hinged joint.
3. *Swinging laterally on vertical pin.*
4. *Rotating on parallel longitudinal pin.*

Class B. Movement of Breech-block.

1. *Sliding longitudinally backward*
   - (*a.*) Operated by a lever.
   - (*b.*) Withdrawn by hand by a thumb or spring catch, or by a handle, and fastened by a bayonet-catch.
2. *Swinging or tilting*
   - (*a.*) Hinged to top of barrel and turning upward and forward.
   - (*b.*) Hinged to side of barrel and swinging laterally forward.
   - (*c.*) Hinged beneath barrel and swinging forward and downward through mortise.
   - (*d.*) Swinging on centers or trunnions.
   - (*e.*) Hinged at rear, to swing upward and backward.
   - (*f.*) Hinged at rear and swinging laterally.
   - (*g.*) Hinged at rear and swinging downward and backward through mortise.
3. *Sliding transversely through mortise*
   - (*a.*) Moving vertically.
   - (*b.*) Moving laterally.
4. *Swinging or rotating laterally*
   - (*a.*) On a longitudinal pin or hinge.
   - (*b.*) Having the form of a rotating sleeve.
5. *In form of a faucet or spigot*
   - (*a.*) Having chamber in the faucet.
   - (*b.*) Having chamber in the barrel in front of faucet.

Class C. Revolvers.

1. *Chambered cylinder revolving on parallel axis*
   - (*a.*) Behiud a barrel; cylinder charged in front.
   - (*b.*) Behind a barrel; cylinder charged at rear.
   - (*c.*) Cylinder without other barrel ("pepper-box").
2. *Chambered cylinder revolving on vertical axis, behind a barrel.*
3. *Chambered cylinder revolving on horizontal transverse axis, behind a barrel.*
4. *Revolving hammer acting on several stationary barrels.*

CLASSIFIED LIST OF BREECH-LOADING FIRE-ARMS PATENTED IN THE UNITED STATES.

[The star (*) designates magazine-guns.]

CLASS A. — BARRELS MOVING WITH RELATION TO THE STOCK OR BREECH.

1. *Sliding Longitudinally Forward.*

No.	Name.	Date.
8,690	C. V. Nickerson	Jan. 27, 1852.
14,253	Robertson and Simpson	Feb. 12, 1856.
16,288	Schroeder, Salewski, and Schmidt	Dec. 23, "
17,644	G. Smith	June 23, 1857.
17,915	T. Buckman	Aug. 4, "
23,505	T. E. Shull	Apr. 5, 1859.
24,437	T. Bailey	June 14, "
24,936	A. V. Hill	Aug. 2, "
28,460	W. H. Elliot	May 29, 1860.
31,809	E. Lefaucheur	Mar. 26, 1861.
32,421	A. V. Hill	May 8, "
32,790	C. Sharps	July 9, "
34,561	W. H. Brown	Mar. 4, 1862.
43,284	F Beals	June 28, 1864.
*45,638	R. Roberts	Dec. 27, "
46,207	F. Beals	Feb. 7, 1865.
*46,286	H. F. Wheeler	Feb. 7, "
51,837	B. F. Joslyn	Jan. 2, 1866.
52,258	F. Beals	Jan. 30, "
58,525	D. Williamson	Oct. 2, "
65,704	R. E. Stephens	June 11, 1867.
*66,110	H. F. Wheeler	June 25, "
66,913	Thrasher and Aiken	July 16, "
70,264	S. S. Rembert	Oct. 29, "
71,349	E. Whitney	Nov. 26, "
76,734	C H. Alsop	Apr. 7, 1868.
82,908	D. Werner	Oct. 6, "
*87,038	W. Gardner	Feb. 16, 1869.
88,605	W. Briggs	Apr. 6, "
92,799	L. Delassize	July 20, "
*112,795	H. K. Forbis	Mar. 21, 1871.

2. *Tilting.* (*a.*) *Down at Muzzle and up at Breech.*

147	T. McCarty	Mar. 11, 1837.
203	H. C. Fay	May 22, "
960	S. Adams	Oct. 3, 1838.
1,810	S. Day	Oct. 18, 1840.
8,126	E. Maynard	May 27, 1851.
11,477	J. C. Day	Aug. 8, 1854.
13,941	J. C. Day	Dec. 18, 1855.
14,057	L. H. Gibbs	Jan. 8, 1856.
16,761	Tilton and Floyd	Mar. 3, 1857.
17,642	J. P. Schenkl	June 23, "
22,752	C. Sharps	Jan. 25, 1859
24,730	Gallagher and Gladding	July 12, "
25,926	Wesson and Harrington	Oct. 25, "
26,364	E. Maynard	Dec. 6, "
27,399	J. M. Wamplcr	Mar. 6, 1860.
27,723	Letort and Mathews	Apr. 3, "
29,152	M. J. Gallagher	July 17, "
30,228	F. Jones	Oct. 2, "
30,372	C. O. Wood	Jan. 1, 1861.
31,050	C. O. Wood	Jan. 1, "
32,653	H. Schroder	June 25, "
32,895	C. D. Schubarth	July 23, "
36,571	M. Moses	Sept. 30, 1862.
36,925	F. Wesson	Nov. 11, "
39,494	J. Percy	Aug. 11, 1863.
39,707	C. E. Sneider	Aug. 25, "
42,648	W. H. Elliot	May 10, 1864.
42,649	W. H. Elliot	May 10, "
42,698	E. T. Starr	May 10, "
43,929	G. J. Richardson	Aug. 23, "
44,123	J. Stevens	Sept. 6, "
44,290	W. C. Dodge	Sept. 20, "
44,312	W. D. Hillis	Sept. 20, "
46,054	C. E. Sneider	Jan. 24, 1865.
47,755	C. E. Sneider	May 16, "
48,966	E. Maynard	July 25, "
50,048	T. L Sturtevant	Sept. 19, "
50,432	W. Richards	Oct. 10, "
50,854	T. L. Sturtevant	Nov. 7, "
52,654	A. Henry	Feb. 13, 1866.

2. *Tilting.* (*a.*) *Down at Muzzle, etc.* — Continued.

No.	Name.	Date.
52,938	J. F. C. Carle	Feb. 27, 1866.
55,613	J. Burke	June 19, "
59,110	E. Wetmore	Oct. 23, "
59,706	P. Bourdereaux	Nov. 13, "
59,723	W. H. Miller	Nov. 13, "
60,592	T L. Sturtevant	Dec. 18, "
62,465	A. 1. Burgess	Feb. 26, 1867.
64,941	G. W. Bowlby	May 21, "
65,783	T. W. Webley	June 11, "
70,463	W. R. Pape	Nov 5, "
71,149	J. Elson	Nov. 19, "
72,434	D. B. Wesson	Dec. 17, "
78,519	E. H. Escherich	June 2, 1868.
78,847	D. B. Wesson	Junc 9, "
84.373	W. R. Pape	Nov. 24, "
85,252	C. E. Sneider	Dec. 22, "
87,814	G. T. Abbey	Mar. 16, 1869.
88,470	W. Golcher	Mar. 30, "
88,890	J. McGovern	Apr. 13, "
89,947	G. Schulz	May 11, "
90,214	F. Wohlgemuth	May 18, "
91,616	L. T. Fairbanks	June 22, "
91,624	J. A Hackenback	June 22, "
93,023	G. H. Todd	July 27, "
95,998	W. Golcher	Oct. 19, "
100,455	E. L. Sargent	Mar. 1, 1870.
104,502	E. L. Sargent	Junc 21, "
104,682	L. V. Young	June 21, "
108,942	M. M. Scott	Nov. 1, "
109,255	E. L. Sargent	Nov. 15, "
109,890	C. Green	Dec. 6, "
112,763	W. C. Dodge	Mar. 14, 1871.
114,081	Abbey and Foster	Apr. 25, "
114,230	Tiesing and Gerner	Apr. 25, "
114,374	D. B. Wesson	May 2, "
114,653	W. C. Dodge	May 9, "
117,843	A. E. Whitmore	Aug. 8, "
118,350	Dodge and Dodge	Aug. 22, "
119,474	G. R. Peirce	Oct. 3, "
119,834	G. H. Ferriss	Oct. 10, "
125,775	A. E. Whitmore	Apr. 16, 1872.
130,984	F. S. Dangerfield	Sept. 3, "
131,484	H. Walker	Sept. 17, "
135,928	E. Maynard	Feb. 18, 1873.
138,887	J. S. Heath	May 13, "
141,198	P. Bourdereaux	July 29, "

2. (*b.*) *With Muzzle upward.*

24,774	P. Altmaier	July 12, 1859.
34,729	H Berg	Mar. 25, 1862.
51,440	W H. Elliot	Dec. 12, 1865.

2. (*c.*) *On Hinged Joint.*

15,496	G. Smith	Aug. 5, 1856.
22,094	J. C. Symmes	Nov. 16, 1858.
23,762	W. C. Ellis	Apr. 26, 1859.
27,600	E. Sneider	Mar. 20, 1860.
32,929	A. Spellerberg	July 30, 1861.
35,356	H. Kellogg	May 20, 1862.
49,844	J. D. Dougall	Sept. 5, 1865.
54,680	J. Burke	May 15, 1866.
60,698	S. Crispin	Jan. 1, 1867.
93,403	J. D. Blaker	Aug. 10, 1869.

3. *Swinging Laterally on Vertical Pin.*

35,941	J. Lee	July 22, 1862.
43,259	S. M. Perry	June 21, 1864.

3. *Swinging Laterally on Vertical Pin.* — Continued.

No.	Name.	Date.
43,260	S. M. Perry	June 21, 1864.
46,617	E. Allen	Mar. 7, 1865.
47,396	J. W. Cochran	Apr. 25, "
51,959	F. D. Newbury	Jan. 9, 1866.
63,605	C. H. Ballard	Apr. 9, 1867.
98,579	G. H. Fox	Jan. 4, 1870.
101,637	J. M. Marlin	Apr. 5, "
102,429	Perry and Goddard	Apr. 26, "
102,434	E. S. Renwick	Apr. 26, "
105,388	F. A. Thuer	July 12, "
137,927	A. E. and P. J. Jarre	Apr. 15, 1873.

4. *Rotating on Parallel Longitudinal Pin.*

8,637	R. S. Lawrence	Jan. 6, 1852.
11,157	J. D Greene	June 27, 1854.
13,691	H. B. Weaver	Oct. 16, 1855.
*14,034	J. C. Smith	Jan. 1, 1856.
*27,374	J. D. Moore	Mar. 6, 1860.

4. *Rotating on Parallel Longitudinal Pin.* — Continued.

No.	Name.	Date.
27,778	C. Cox	Apr. 10, 1860.
29,340	R. F. Cook	July 24, "
31,473	D. Moore	Feb. 19, 1861.
*32,316	L. Siebert	May 14, "
35,241	W. Johnston	May 13, 1862.
37,025	Armstrong and Taylor	Nov. 25, "
*37,854	R. F. Cook	Mar. 10, 1863.
37,937	Jacksou and Goodrum	May 17, "
42,227	A. H. Rowe	Apr. 5, 1864.
43,571	Francis Clark	July 19, "
43,840	W. H. Elliot	Aug. 16, "
44,868	W. Johnston	Nov. 1, "
*45,361	L. Triplett	Dec. 6, "
49,057	M. L. M. Descoutures	July 25, 1865.
50,760	H. F. Wheeler	Oct. 31, "
55,752	H. F. Wheeler	June 19, 1866.
58,064	W. J. Christy	Sept 18, "
73,494	Boyd and Tyler	Jan. 21, 1868.
88,540	Boyd and Tyler	Apr. 6, 1869.
103,694	F. Wesson	May 31, 1870.
106,083	Simpson, Gray, and Romans	Aug. 2, "
112,803	Gray and Romaus	Mar. 21, 1871.

Class B. — Breech-Block moving with Relation to Barrel.

1. *Sliding Longitudinally Backward.* (*a.*) *Operated by a Lever.*

No.	Name.	Date.
747	W. Jenks	May 25, 1838.
7 443	W. W. Marston	June 18, 1850.
*8,317	H. Smith	Aug. 26, 1851.
*10,535	Smith and Wesson	Feb. 14, 1854.
15,995	G. W. Morse	Oct. 28, 1856.
16,797	W. C. Hicks	Mar. 10, 1857.
20,825	G. H. Soule	July 6, 1858.
20,954	J. H. Merrill	July 20, "
*30,446	B. F. Henry	Oct. 16, 1860.
30,714	J. Boynton	Nov. 27, "
32,032	J. H. Merrill	Apr. 9, 1861.
32,033	J. H. Merrill	Apr. 9, "
32,451	J. H Merrill	May 28, "
33,536	J. H. Merrill	Oct. 22, "
33,847	D. Moore	Dec. 3, "
34,859	C. B. Holden	Apr. 1, 1862.
35,284	W. H. Elliot	May 13, "
35,989	C. C. Brand	July 29, "
*36,174	J. Q. A Scott	Aug. 12, "
36,721	J. V. Meigs	Oct. 21, "
36,779	S. Howard	Oct. 28, "
37,376	Le Roy S. White	Jan. 6, 1863.
38,280	C. C. Brand	Apr. 28, "
38,645	E. H. Asheroft	May 26, "
38,943	C C. Brand	June 23, "
40,884	J. H. Merrill	Dec. 8, "
41,814	W. C. Hicks	Mar. 1, 1864
42,941	H. Gross	May 31, "
45,202	Bergen and Williamson	Nov. 22, "
*45,466	J. F. Appleby	Dec. 20, "
46,977	D. Williamson	Mar. 21, 1865.
48,337	Joshua Gray	June 20, "
49,463	W. F. Wilson and H. Flather	Aug. 15, "
50,125	C. Howard	Sept. 26, "
50,358	C. Howard	Oct. 10, "
*52,933	J. D. Smith	Feb 27, 1866.
*52,934	J. D Smith	Feb. 27, "
*55,012	N. King	May 22, "
*56,939	H. W. Hayden	Aug. 7, "
*57,636	N. King	Aug. 28, "
*57,808	O. F. Winchester	Sept. 4, "
*58,937	G. W. Briggs	Oct. 16, "
*59,126	V. Fogerty	Oct. 23, "
*63,564	P. Sheckler	Apr. 2, 1867.
65,812	W. W. Hubbell	June 18, "
*66,751	E. L. Sturtevant	July 16, "
68,786	M. Pidault and G. Elieze (dit Lagieze)	Sept. 10, "
*82,819	V. Fogerty	Oct. 6, 1868.
*84,598	L. Wheelock	Dec. 1, "
85,616	P. Schuler	Jan. 5, 1869.
*86,723	S. G. Bayes	Feb. 9, "

1. *Sliding Longitudinally Backward.* (*a.*) *Operated by a Lever.* — Continued.

No.	Name.	Date.
86,739	T. M. Deprez	Feb. 9, 1869.
86,971	T. B. Conklin	Feb. 16, "
87,997	D. Williamson	Mar. 16, "
*111,500	L. Wheelock	June 31, 1871.
*112,563	H. J. Drew	Mar. 14, "
*112,564	H. J. Drew	Mar. 14, "
*116,642	G. R. Stetson	July 4, "
*125,988	O. M. Robinson	Apr. 23, 1872.
127,873	William W. Haunah	June 11, "

1. (*b.*) *Withdrawn by Hand by a Thumb or Spring Catch, or by a Handle, and fastened by a Bayonet-Catch.*

6,871	C. Hartung	Nov. 13, 1849.
*6,973	L. Jennings	Dec. 25, "
7,334	J. Murfflein	Apr. 30, 1851.
11,198	A N. Newton	June 27, 1854.
11,835	C. F. and A H. Palmire	Oct. 24, "
11,938	F. Maton	Nov. 14, "
15,522	A. N. Newton	Aug. 12, 1856.
16,072	C. Sharps	Nov. 11, "
18,634	J. Durell Greene	Nov. 17, 1857.
25,470	J. Rider	Sept. 13, 1859.
26,475	B. Burton	Dec. 20, "
32,450	J. H. Merrill	May 28, 1861.
34,084	F. G. Woodard	Jan. 7, 1862.
34.422	J. D. Greene	Feb. 18, "
34,706	T. Twickcler	Mar. 18, "
34,911	J. L Swan	Apr. 8, "
35,107	J. P. Marshall	Apr. 29, "
36,681	W. Terry	Oct. 14, "
36,854	J. C. Nye	Nov. 4, "
37,354	J. C. Nye	Jan. 6, 1863.
37,723	J. K. Millner	Feb. 17, "
38,903	O. D. Lull	June 16, "
39,136	W. H. Elliot	July 7, "
40,572	W. Morgenstern and E. Morwitz	Nov. 10, "
41,017	W. Palmer	Dec. 22, "
44,099	W. R. Landfear	Sept. 6, 1864.
44,127	Townsend and Clement	Sept. 6, "
44,545	D. F. Mellen	Oct. 4, "
45,262	W. Morgenstern	Nov. 29, "
48,133	W. Morgenstern	June 6, 1865.
50,334	N. S. Clement	Oct. 10, "
60,832	A. A. Chassepot	Jan. 1, 1867.
63,217	J. W. Cochran	Mar. 26, "
63,303	Thomas Restell	Mar. 26, "
65,509	E. K. Root	June 4, "
73,351	H. Lord	Jan 14, 1868.
74,387	H. Lord	Feb. 11, "

1. (*b.*) *Withdrawn by Hand, etc.* — Continued.

No.	Name.	Date.
75,627	J. W. Cochran	Mar. 17, 1868.
78,603	S. Morris, W. and P. Mauser	Juue 2, "
80,043	Thomas Wilson	July 14, "
81,059	B. Burton	Aug. 11, "
81,290	C. B. Richards	Aug. 18, "
*84,459	A. Wylie	Nov. 24, "
85,162	H. Berdan	Dec. 22, "
*85,494	F. Vetterlin	Dec. 29, "
85,645	J. W. Cochran	Jan. 5, 1869.
*85,897	C. W. Baldwin	Jan. 19, "
85,999	Carter and Edwards	Jan. 19, "
86,091	L. A. Merriam	Jan. 19, "
*86,520	V. Fogerty	Feb. 2, "
86,566	E. Maynard	Feb. 2, "
86,690	L. Remington	Feb. 9, "
87,058	L. A. Merriam	Feb. 16, "
88,161	J. D. Greene	Mar. 23, "
88,730	J. D. S. Newell	Apr. 6, "
89,902	S. F. Van Choate	May 11, "
90,381	J. D. S. Newell	May 25, "
*92,013	B. Burton	Juue 29, "
92,048	M. J. Hinden	June 29, "
*92,129	W. G. Ward	June 29, "
93,822	B. B. Hotchkiss	Aug. 17, "
94,047	S. F. Van Choate	Aug. 24, "
94,458	W. G. Ward	Aug. 31, "
94,577	F. V. Diaz	Sept. 7, "
97,167	A. A. Chassepot	Nov. 23, "
97,734	W. G. Ward	Dec. 7, "
*97,821	W. S. Smoot	Dec. 14, "
99,504	W. G. Ward	Feb. 1, 1870.
99,898	B. B. Hotchkiss	Feb. 15, "
101,826	J. J. Cloes	Apr. 12, "
103,488	A. Muller	May 24, "
*103,504	O. M. Robinson	May 24, "
104,100	K. V. Barnekoo	June 14, "
108,836	P. Schuler	Nov. 1, "
108,869	H. Berdan	Nov. 1, "
109,218	B. F. Joslyn	Nov. 15, "
109,277	F. Vetterlin	Nov. 15, "
109,731	J. Hanson	Nov. 29, "
110,353	S Gerngross	Dec. 20, "
110,505	J. Smiles	Dec. 27, "
111,994	W. G. Ward	Feb. 21, 1871.
112,523	J. M Mason	Mar. 7, "
115,911	S. F. Van Choate	June 13, "
117,398	Valentine Fogerty	July 25, "
119,939	George Merrill	Oct. 17, "
119,940	George Merrill	Oct. 17, "
124,056	R. Goshen	Feb. 27, 1872.
125,829	I. M. Milbank	Apr. 16, "
129,312	H. Brugmann	July 16, "
132,505	S. F. Van Choate	Oct. 22, "
134,200	F. Gueury	Dec. 24, "
135,850	I. M. Milbank	Mar. 18, 1873.
135,998	H. Hoppeneau	Mar. 18, "

2. *Swinging or Tilting.* (*a.*) *Hinged to Top of Barrel, and turning Upward and Forward.*

610	H. and C. Dauiels	Feb. 15, 1838.
1,611	J. R. Thomas	May 19, 1840.
13,507	B. F. Joslyn	Aug. 28, 1855.
14,949	N. S. Clement	May 27, 1856.
15,307	W. M. Storm	July 8, "
15,516	F. W. Hoffman	Aug. 12, "
25,661	J. P. Marshall	Oct. 4, 1859.
33,655	S. W. Marsh	Nov. 5, 1861.
*34,776	L. C. Rodier	Mar. 25, 1862.
36,531	B. S. Roberts	Sept. 23, "
39,246	W. Richards	July 14, 1863.
40,151	J. H. Wickman	Sept. 29, "
45,126	E. S. Wright	Nov. 5, 1864.
47,163	C. Chabot	Apr. 4, 1865.
47,902	W. H. and G W. Miller	May 23, "
49,718	C. Chabot	Sept. 5, "
49,959	E. S. Allin	Sept. 19, "
51,391	E. S. Piper	Dec. 5, "
52,734	I. M. Milbank	Feb. 20, 1866.
52,887	B. S. Roberts	Feb. 27, "
52,925	H. Berdan	Feb. 27, "
54,600	H. Reynolds	May 8, "
55,520	I. M. Milbank	June 12, "
57,269	J. H. Selwyn	Aug. 14, "
60,664	A. Ball	Jan. 1, 1867.
61,082	I. M. Milbank	Jan. 8, "

2. *Swinging or Tilting, etc.* — Continued.

No.	Name.	Date.
61,865	J. W. Preston	Feb. 5, 1867.
64,701	Poultney and Crispin	May 14, "
65,585	I. M. Milbank	June 11, "
68,099	W. H. and G. W. Miller	Aug. 27, "
72,526	W. Morgensteru	Dec. 24, "
74,119	F. Muller	Feb. 4, 1868.
79,291	W. Morgenstern	June 23, "
86,434	W. Morgenstern	Feb. 2, 1869.
87,190	W. Morgenstern	Feb. 23, "
88,436	H. Berdan	Mar 30, "
88,530	A. L. Varney	Mar. 30, "
88,531	A. L. Varney	Mar. 30, "
89,889	W. Richards	May 11, "
90,792	W. S. Smoot	June 1, "
93,330	W. Morgenstern	Aug. 3, "
101,418	H. Berdan	Apr. 5, 1870.
105,058	A. B. Ely and E. C. Clay	July 5, "

2. (*b.*) *Hinged to Side of Barrel and Swinging Laterally Forward.*

50,670	Jvon der Papperburg	Oct. 24, 1865.
55,719	A. Sayer	June 19, 1866.
61,715	I. M. Milbank	Feb. 5, 1867.
64,999	J and G. H. Needham	May 21, "
81,283	J. Merlett	Aug. 18, 1868.
84,566	I. M. Milhank	Dec. 1, "
109,419	A. B Kay	Nov. 22, 1870.

2. (*c*) *Hinged beneath Barrel and Swinging Forward and Downward through Mortise.*

12,001	A. D. Perry	Nov. 28, 1854.
12,638	R. White	Apr. 3, 1855.
14,491	A. F. Burnside	Mar. 25, 1856.
15,521	F. D. Newbury	Aug. 12, "
20,073	T. Lee	Apr. 27, 1858.
21,523	E. T. Starr	Sept. 14, "
25,470	J. Rider	Sept. 13, 1859.
26,362	S. W. Marsh	Dec. 9, "
*27,393	C. M. Spencer	Mar. 6, 1860.
27,509	N. L. Babcock	Mar. 20, "
27,874	G. P. Foster	Apr. 10, "
33,317	F. Curtis	Sept 17, 1861.
33,745	T. Lee	Nov. 19, "
35,217	C. C. Coleman	May 13, 1862.
35,354	J. M. Seymour	May 20, "
35,488	J. C. Cooke	June 3, "
*36,062	C. M. Spencer	July 29, "
36,466	F. W. Howe	Sept. 16, "
37,501	L. Geiger	Jan. 27, 1863.
38,042	I. Hartshorn	Mar. 31, "
39,120	J. W. Cochrau	July 7, "
39,646	H. Gross	Aug. 25, "
40,887	J. Rider	Dec. 8, "
40,992	J. W. Cochran	Dec. 22, "
41,281	F. Curtis	Jan. 19, 1864.
41,489	F. Curtis	Feb. 9, "
42,471	G. Hancock	Apr. 26, "
42,702	F. Trulender	May 10, "
43.957	W H. Smith	Aug. 23, "
*45.043	G. W. Hughes	Nov. 15, "
45,123	J. Rider	Nov. 15, "
45,152	A. Grillet	Nov. 22, "
*45,356	E. Stabler	Dec. 6, "
45,797	J. Rider	Jan. 3, 1865.
*45,952	C. M. Spencer	Jan. 17, "
46,671	F. W. Howe	Mar. 7, "
*46.828	E. Stabler	Mar. 14, "
46,866	1. Sutvan	Mar. 14, "
47,350	A. M White	Apr. 18, "
47,372	W. H Elliot	Apr. 18, "
47,809	W. H. Elliot	May 23, "
48.227	H. H. Wolcott	Juue 13, "
48,288	B. F. Joslyn	Juue 20, "
*49,409	Hughes and Busey	Aug. 15, "
49,994	Foster and Foster	Sept. 19, "
50,507	J. Stillman	Oct. 17, "
51,739	W. H. aud G. W. Miller	Dec. 26, "
51.991	H. Berdan	Jan. 9, 1866.
*52,547	W. C. Dodge	Feb. 13, "
53,187	Robertson and Simpson	Mar. 13, "
53,543	J. Rider	Mar. 27, "
*54,068	J. Gray	Apr. 17, "

2. (*c.*) *Hinged beneath Barrel, etc.* — Continued.

No.	Name.	Date.
54,100	C. E. Billings	Apr. 24, 1866.
54,743	Laidley and Emery	May 15, "
56,399	G. P. and G. F. Foster	July 17, "
56,890	J. Bradley	Aug. 7, "
58,444	R. McChesney	Oct. 2, "
*58,737	C. M. Spencer	Oct. 9, "
*58,738	C. M. Spencer	Oct. 9, "
59,500	C. C. Coleman	Nov 6, "
60,106	H. H. Woleott	Nov. 27, "
*60,910	T. W. Lane	Jan. 1, 1867.
60,998	H. M. and M. J. Chamberlain	Jan. 8, "
61,722	Silas Crispin	Feb. 5, "
62,873	A. S. Munger	Mar. 12, "
64,786	W. H. and G. W. Miller	May 14, "
65,103	R. McChesney	May 28, "
*67,242	J. A. Whitney	July 30, "
68,250	W. S. Smoot	Aug. 27, "
68,292	W. H. Elliot	Aug. 27, "
72,803	L. Conroy	Dec. 31, "
74,428	J. Rider	Feb. 11, 1868.
74,760	B. H. Jenks	Feb. 25, "
76,595	J. Broughton	Apr. 14, "
89,699	A. C. Steveus	May 4, 1869.
91,421	L. Conroy	June 15, "
92,393	J. T. Stoakes	July 6, "
104,211	G. W. Schofield	June 14, 1870.
104,337	J. M. Whittemore	June 14, "
111,814	M. J. Chamberlain	Feb. 14, 1871.
112,505	Smith and Chamberlain	Mar 7, "
112,694	W. C. and P. T. Dodge	Apr. 4, "
112,997	E. Whitney	Mar. 21, "
113,408	W. C. Dodge	Apr. 4, "
113,470	Tresing and Gerner	Apr. 4, "
114,742	J. Yglesias	May 9, "
115,997	Eli Whitney	June 13, "
116,106	W. S. Smoot	June 20, "
116,363	W. T. Snedden	June 27, "
116,364	W. T. Snedden	June 27, "
117,906	James M. Mason	Aug. 8, "
*118,152	J. Rider	Aug. 15, "
*119,020	W. R. Evans	Sept. 19, "
119,098	Horace Updegraff	Sept 19, "
120,788	W. S. Smoot	Nov. 7, "
122,465	B. B. Hotchkiss	Jan. 2, 1872.
122,470	James Lee	Jan. 2, "
122,717	A. T. Freeman	Jan. 16, "
124,994	Eli Whitney	Mar. 26, "
125,229	John F. Thomas	Apr. 2, "
126,446	John W. Coehran	May 7, "
127,386	John F. Thomas	May 28, "
127,683	W. C. and P. T. Dodge	June 11, "
129,393	M. J. Chamberlain	July 16, "
129,433	D Smith	July 16, "
*129,523	A. Burgess	July 16, "
129,637	E. Whitney and F Tresing	July 16, "
130,165	H. Updegraff	Aug. 6, "
131,487	J. M. Whittemore	Sept. 17, "
131,921	J. M. Whittemore	Oct. 1, "
132,740	W. Mont Storm	Nov. 5, "
133,063	W. S. Smoot	Nov. 12, "
*134,589	A. Burgess	Jan. 17, 1873.
135,405	M. J. Chamberlin	Feb. 4, "
135,671	C. M. Spencer	Feb. 11, "
137,625	C. Sharps	Apr. 8, "
138,157	Holt and Marshall	Apr. 22, "
138,207	D. Smith	Apr. 22, "
141,333	J. Rider	July 20, "
141,334	J. Rider	July 20, "
141,603	Smith and Marshall	Aug 5, "
142,396	D. Hug	Sept. 2, "

2. (*d.*) *Swinging on Centers or Trunnions.*

*10,084	E. H. Graham	Oct. 4, 1853.
10,391	J. D. Greene	Jan. 3, 1854.
*11,944	E. H. Graham	May 16, "
12,244	A. D. Perry	Jan. 16, 1855.
12,903	H. Gross	May 22, "
14,819	E. Snider	May 6, 1856.
*15,734	E. H. Graham	Sept. 16, "
17,133	G. A. Blittkowski	Apr. 28, 1857.
39,270	G. R. Bacon	July 21, 1863.
39,455	J. S. Adams	Aug. 14, "
44,377	J. S Adams	Sept. 27, 1864.
45,495	H. W. Hayden	Dec. 20, "

2. (*e.*) *Hinged at Rear to swing Upward and Backward.*

No.	Name.	Date.
...	William Thornton and J. H. Hall	May 21, 1811.
865	H. L. Thistle	Aug. 1, 1838.
1,141	N. Starr	May 3, 1839.
3,686	Savage and North	July 30, 1844.
5,141	H. S. North	June 5, 1847.
11,536	W. A Sweet	Aug 15, 1854.
*12,567	A. T. Watson	Mar. 20, 1855.
15,072	H. Gross	June 10, 1856.
18,472	Skinner and Tryon	Oct. 20, 1857.
19,068	W. Burghart	Jan. 12, 1858.
20,503	G. W. Morse	Juue 8, "
*21,149	F. B. Prindle	Aug. 10, "
23,224	Barber and Reinfried	Mar. 15, 1859.
23,378	E. Lindner	Mar. 29, "
24,394	D. Leavitt	June 14, "
25,259	H. Gross	Aug. 30, "
26,076	W. H. Arnold	Nov. 15, "
32,887	W. Palmer	July 23, 1861.
*34,922	C. Dragar	Apr. 8, 1862.
*35,548	N. Smith	June 10, "
36,891	Bostwick and Sargent	Nov. 11, "
37,048	I. M. Milbank	Dec. 2, "
37,407	J. Oliphant	Jan. 13, 1863.
37,764	C. Perley	Feb. 24, "
*39,541	J. N. Smith	Aug. 18, "
43,733	J. Browness	Aug. 2, 1864.
47,088	J. W. Coehran	Apr. 14, 1865.
51,213	F. B. Prindle	Nov. 28, "
52,679	J. W. Coehran	Feb. 20, 1866.
*135,947	Swingle and Huntington	Feb. 18, 1873.

2 (*f.*) *Hinged at Rear and swinging Laterally.*

409	C. Parkhurst	Sept. 25, 1837.
34,319	C. M. Spencer	Feb. 4. 1862.
44,991	E. Whitney	Nov. 8, 1864.
48,073	B. F. Joslyn	June 6, 1865.
133,770	A. T. Freeman	Dec. 10, 1872.
139,190	T. Restell	May 20, 1873.

2. (*g.*) *Hinged at Rear and swinging Downward and Backward through Mortise.*

2,627	C. H. Ballard	Nov. 5, 1851.
12,528	R. White	Mar. 13, 1855.
35,947	H. O. Peabody	July 22, 1862.
36,709	E. Gwyn and A. C. Campbell	Oct. 21, "
*38,702	C. M. Spencer	May 26, 1863.
*38,935	A. Ball	June 23, "
39,479	H. Gross	Aug. 11, "
41,166	J. Merwiu and E. P. Bray	Jan. 5, 1864.
41,242	W. X. Stevens	Jan. 12, "
*43,827	A. Ball	Aug. 2, "
60,607	T. Yates	Dec. 18, 1866.
65,607	B. S. Roberts	Juue 11, 1867.
70,141	L. Wheelock	Oct. 22, "
72,076	H. O. Peabody	Dec. 10, "
76,805	H. O. Peabody	Apr. 14, 1868.
83,442	E. F. Gunn	Dec. 29. 1868.
*89,705	L. Z. Terrell	May 4, 1869.
90,024	B. S. Roberts	May 11, "
90,614	F. Von Martini	May 25, "
91,668	W. Richards	June 22, "
92,673	Z. R. Von Wessely	July 13, "
95,395	A. L. Varney	Sept. 28, "
*105,093	J. Kraffirt	July 5. 1870.
110,024	W H. Elliot	Dec. 13, "
112,565	J. Duval	Mar. 14, 1871.
114,540	W. H. Elliot	May 9, "
114,951	James Lee	May 16, "
115,541	F. Von Martini	May 30, "
116,068	James Lee	June 20, "
117,552	J. Manton	Aug. 1, "
*119,115	A. Burgess	Sept. 19, "
119,218	A. Burgess	Sept. 26, "
120,576	W. H. Elliot	Nov. 7, "
120,800	F. Von Martini	Nov. 7, "
121,499	W. H. Elliot	Dec. 5, "
122,772	James Lee	Jan. 16, 1872.
123,159	J. Duval	Jan 30, "
125,127	W. H. Elliot	Apr. 2, "
127,737	A. Burgess	June 11, "
128,208	A. Burgess	June 25, "
132,222	F. Von Martini	Oct. 15, "

2. (*g.*) *Hinged at Rear, etc.* — Continued.

No.	Name.	Date.
133,665	W. Richards	Dec. 3, 1872.
134,014	J. F. Swinburn	Dec. 17, "

3. *Sliding Transversely through Mortise.* (*a.*) *Moving Vertically.*

No.	Name.	Date.
*1,084	Bailey, Ripley, and Smith	Feb. 20, 1839.
*5,146	E. Wesson	June 5, 1847.
5,763	C. Sharp	Sept. 12, 1848.
*5,814	M. M. Cass	Sept. 26, "
*6,136	G. W. Buchel	Feb. 20, 1849.
*6,663	W. Hunt	Aug. 21, "
*11,283	E. Baldwin	July 11, 1854.
12,529	R. White	Mar. 13, 1855.
*12,655	G. H. Soule	Apr. 3, "
*13,474	J. Swyny	Aug. 21, "
14,554	C. Conant	Apr. 1, 1856.
*14,774	F. Newbury	Apr. 29, "
15,240	B. F. Joslyn	July 1, "
15,347	G. H. Soule	July 15, "
*20,041	C. Cox	Apr. 27, 1858.
22,940	F. Curtis	Feb. 15, 1859.
24,414	W. M. Storm	June 14, "
24,437	T. Bailey	June 14, "
26,504	R. S. Lawrence	Dec. 20, "
*26,734	T. P. Gould	Jan. 3, 1860.
*28,646	N. W. Brewer	June 12, "
30,033	E. Allen	Sept. 18, "
*30,760	J. S. Reeder	Nov. 27, "
33,607	C. Sharps	Oct. 29, 1861.
33,769	A. Hamilton	Nov. 19, "
34,325	G. W. White	Feb. 4, 1862.
*34,504	E. M. Judd	Feb. 25, "
35,086	F. Dewzler	Apr. 29, "
37,369	G. W. White	Jan. 6, 1863
37,544	J. Davis	Jan. 27, "
38,455	W. Aldrich	May 12, "
*38,604	W. H. Rice	May 19, "
41,343	Mix and Horton	Jan. 9, 1864.
*41,375	J. Gray	Jan. 26, "
42,139	C. B. Holden	Mar. 29, "
42,685	C. F. Payne	May 10, "
42,748	L. N. Chapin	May 17, "
*44,995	J. Gray	Nov. 8, "
*45,105	R. Wilson	Nov. 15, "
*45,560	J. Gray	Dec. 20, "
*45,919	W. Fitzgerald	Jan. 17, 1865.
49,583	L. W. Broadwell	Aug. 22, "
51,243	W. Tibbals	Nov. 28, "
51,258	J. Davis	Nov. 28, "
54,744	J. Lee	May 15, 1866.
54,934	J. V. Meigs	May 22, "
59,540	J. N. Aronsou	Nov. 13, "
62,077	C. Sharps	Feb. 12, 1867.
64,650	J. Elson	May 14, "
66,709	A. J. H. Hilton	July 16, "
67,033	J. Elsou	July 23, "
81,100	J. V. Meigs	Aug. 18, 1868.
86,387	Elson and Schaefer	Feb. 21, 1869.
88,645	R. S. Lawrence	Apr. 16, "
*88,853	T. Cullen	Apr. 13, "
89,955	L. B. Tiebel	May 11, "
*101,845	D. Ellis	Apr. 12, 1870.
104,775	S. Rydberk	June 28, "
114,259	H. Buchner	May 2, 1871.
*116,066	J. L. Kirk	June 20, "
119,145	Henry	Sept. 19, "
123,595	G. H. Tibbets	Feb. 13, 1872.
126,748	C. F. Russell	May 14, "
*136,660	G. D. Luce	Mar. 11, 1873.
*138,439	Rodier and Bates	Apr. 29, "
138,837	G. Aston	May 13, "
139,323	A. Marelli	May 27, "
139,422	W. Richards	May 27, "

3. (*b.*) *Moving Laterally.*

No.	Name.	Date.
168	Fisher and Chamberlin	Apr. 17, 1837.
14,667	P. Lancaster	Apr. 15, 1856.
*19,387	C. C. Terrill	Feb. 16, 1858.
33,560	Vittum and Stevens	Oct. 22, 1861.
35,685	P. J. Jarre	June 24, 1862.
51,225	E. Schopp	Nov. 28, 1865.

4. *Swinging or rotating Laterally.* (*a.*) *On a Longitudinal Pin or Hinge.*

No.	Name.	Date.
193	W. W. Hubbell	Mar. 11, 1837.
*364	S. Day	Aug. 31, "
3,649	W. W. Hubbell	July 1, 1844.
6,139	D. Minesinger	Feb. 27, 1849.
*9,701	C. N. Tyler	May 3, 1853.
*14,017	B. Groom	Jan. 1, 1856.
*14,406	F. Newbury	Mar. 1, "
20,315	C. W. Alexander	May 25, 1858.
26,526	I. H. Sears	Dec. 20, 1859.
30,537	E. Maynard	Oct. 30, 1860.
33,435	B. F. Joslyn	Oct. 8, 1861.
33,907	W. H. Smith	Dec. 10, "
*34,126	Brady and Noble	Jan. 14, 1862.
34,449	B. F. Skinner and A. Plummer, Jr.	Feb. 18, "
34,854	S. W. Wood	Apr. 1, "
35,688	B. F. Joslyn	June 24, "
*35,996	J. B. Doolittle	July 29, "
*36,358	J. Nichols	Sept. 2, "
37,208	S. Strong	Dec. 16, "
38,366	L. Albright	May 5, 1863.
38,643	S. Strong	May 19, "
38,644	S. Strong	May 19, "
39,198	J. Davis	July 7, "
39,407	B. F. Joslyn	Aug. 4, "
41,732	J. Warner	Feb. 23, 1864.
42,000	B. F. Joslyn	Mar. 22, "
42,529	J. Davis	Apr. 25, "
42,542	I. Smith	Apr. 26, "
42,573	J. Goulding	May 3, "
44,798	H. Hammond	Oct. 25, "
45,660	J. Warner	Dec. 27, "
45,701	Francis Clark	Jan. 3, 1865.
45,899	Hiram Berdan	Jan. 10, "
46,125	I. M. Milbank	Jan. 31, "
46,532	J. Rider	Feb. 21, "
48,423	E. Maynard	June 27, "
49,130	E. Maynard	Aug. 1, "
49,491	E. Allen	Aug. 22, "
53,523	F. Clark	Mar. 27, 1866.
56,669	J. A. Conover	July 24, "
*56,846	A. M. Bacon	July 31, "
68,733	E. F. Gunn	Sept. 10, 1867.
69,941	J. Snider, Jr.	Oct. 15, "
72,849	H. Hammond	Dec. 31, "
73,357	J. E. McBeth	Jan. 14, 1868.
74,712	W. Morgenstern	Feb. 18, "
74 737	J. Werndl	Feb. 18, "
74,888	C. Callaghan	Feb. 25, "
80,985	J. E. McBeth	Aug. 11, "
84,922	E. Von Jeinsen	Dec. 15, "
84,929	E. Allen	Dec. 15, "
84,933	J. R. Cooper	Dec. 15, "
85,268	Belden and Crabtree	Dec. 29, "
104,223	W. Soper	June 14, 1870.
*112,127	J. Davis	Feb. 28, 1871.
112,589	H. Hammond	Mar. 14, "
118,171	J. B. Wayne	Aug. 15, "
118,569	J. W. Wilkinson	Aug. 29, "
*122,182	T. Lee	Dec. 26, "
*128,671	C. R. Stickney	July 2, 1872.
129,115	G. H. Earnest	July 16, "
133,711	J. P. Taylor	May 6, 1873.

4. (*b.*) *Having the Form of a Rotating Sleeve.*

No.	Name.	Date.
*7,496	Percival and Smith	July 9, 1850.
16,070	G. Schaeffe	Nov. 11, 1856.

5. *In Form of a Faucet or Spigot.* (*a.*) *Having Chamber in the Faucet.*

No.	Name.	Date.
*6,945	A. D. Perry	Dec. 11, 1845.
*10,520	F. Cook	Feb. 14, 1854.
*19,553	A. C. Faivre	Mar. 9, 1858.
20,776	Brooks and Walker	July 6, "
*23,226	P. Boynton	Mar. 15, 1859.
*26,646	P. Boynton	Jan. 3, 1860.
38,772	H. Underwood	June 2, 1863.
39,232	C. W. Howard	July 14, "
45,801	C. G. Saez	Jan. 3, 1865.

5. (*b.*) *Having Chamber in the Barrel in Front of Faucet.*

No.	Name.	Date.
11,685	H. W. Adams	Sept 19, 1854.
12,681	F. Klein	Apr. 10, 1855.
13,154	E. Allen	July 3, "

5. (*b.*) *Having Chamber in the Barrel, etc.* — Continued.

No.	Name.	Date.
14,077	J. H. Merrill	Jan. 8, 1856.
15,990	T. A. Washington	Oct. 28, "
113,194	R. Henninger	Mar. 28, 1871.

Class C. — Revolvers.

[The dagger (†) signifies that the cylinder has a cartridge-shell extractor.]

1. *Chambered Cylinder revolving on Parallel Axis.* (*a.*) *Behind a Barrel; Cylinder charged at Front.*

No.	Name.	Date.
...	D. G. Colburn	June 29, 1833.
...	Samuel Colt	Feb. 25, 1836.
182	D. Leavitt	Apr. 29, 1837.
*364	S. Day	Aug. 3, "
216	O. W. Whittier	May 30, "
409	C. Parkhurst	Sept. 25, "
698	Theo. F. Strong	Apr. 21, 1838.
707	Nichols and Childs	Apr. 24, "
713	M. Nutting	Apr. 25, "
832	E. Jaquith	July 12, "
1,106	E. B. Butterfield	Mar. 16, 1839.
1,134	D. Edwards	Apr. 27, "
1,304	Samuel Colt	Aug. 29, "
5,316	L. H. Gibbs	Oct. 2, 1847.
6,669	E. Wesson	Aug. 28, 1849.
7,613	Samuel Colt	Sept. 4, 1850.
7,629	Samuel Colt	Sept. 4, "
7,802	J. Stevens	Nov. 26, "
7,894	J. Warner	Jan. 10, 1851.
8,229	J. Warner	July 15, "
8,412	J. Stevens	Oct. 7, "
8,982	North and Skinner	June 1, 1852.
9,694	Robert Adams	May 3, 1853.
9,929	J. Stevens	Aug. 9, "
10,259	M. L. Rood	Nov. 22, "
10,812	J. Ells	Apr. 25, 1854.
10,821	Charles Buso	Apr. 25, "
10,930	J. Peck	May 16, "
11,419	J. Ells	Aug. 1, "
11,447	E. Whitney	Aug. 1, "
11,470	I. W. Brown	Aug. 8, "
11,698	W. H. Morrison	Sept. 19, "
11,715	F. Beals	Sept. 26, "
12,189	J. Stevens	Jan. 2, 1855.
12,328	A. O. H. P. Sehorn	Jan. 30, "
12,470	Hollingsworth and Mershon	Feb. 27, "
12,471	Hollingsworth and Mershon	Feb. 27, "
12,555	F. Newbury	Mar. 20, "
12,649	R. White	Apr. 3, "
12,906	H. Gross	May 22, "
13,039	F. Newbury	June 12, "
13,582	F. Newbury	Sept. 18, "
13,660	W. M. Storm	Oct. 9, "
13,999	E. K. Root	Dec. 25, "
14,406	F. Newbury	Mar. 11, 1856.
14,420	W. M. Storm	Mar. 11, "
14,488	Blittkowski and Hoffman	Apr. 22, "
14,710	Blittkowski and Hoffman	Apr. 22, "
14,905	Samuel Colt	May 20, "
15,110	Alexander Hall	June 10, "
15,144	H. S. North	June 17, "
15,167	F. Beals	June 24, "
15,202	James Warner	June 24, "
15,388	C. S. Petteugill	July 22, "
15,925	Alexander Le Mat	Oct. 21, "
16,367	E. Allen	Jan. 13, 1857.
16,411	A. Tonks	Jan. 13, "
16,575	Brettell and Frisbie	Feb. 10, "
16,683	Samuel Colt	Feb. 24, "
16,716	Samuel Colt	Mar. 3, "
17,032	J. Ellis	Apr. 14, "
17,044	James Kerr	Apr. 14, "
17,143	J. Ellis	Apr. 28, "
17,359	F. Beals	May 26, "
*17,383	E. Lindner	May 26, "
17,698	Jacob Shaw, Jr.	June 30, "
17,904	J. Warner	July 28, "
18,486	George R. Crooker	Oct. 20, "
18,678	Samuel Colt	Nov. 24, "

1. *Chambered Cylinder revolving on Parallel Axis.* (*a.*) *Behind a Barrel; Cylinder charged at Front.* — Continued.

No.	Name.	Date.
18,836	E. Allen	Dec. 15, 1857.
19,327	F. D. Newbury	Feb. 9, 1858.
19,739	F. D. Newbury	Mar. 23, "
19,868	H. S. North	Apr. 6, "
20,144	Samuel Colt	May 4, "
20,160	B. F. Joslyn	May 4, "
20,496	M. Kinsey	June 8, "
20,765	F D. Newbury	June 29, "
21,054	Raymond and Robitaille	July 27, "
21,215	J. Rider	Aug. 17, "
21,478	F. Beals	Sept. 14, "
21,623	William Palmer	Sept. 28, "
21,730	T. R. Austin	Oct. 12, "
22,412	J. W. Cochran	Dec. 28, "
22,511	C. S. Pettengill	Jan. 4, 1859.
22,666	North and Savage	Jan. 18, "
22,905	J. Walch	Feb. 8, "
23,087	W. C. Haynes	Mar. 1, "
23,711	J. Rupertus	Apr. 19, "
23,861	J. Rider	May 3, "
24,274	T. Bailey	June 7, "
24,312	Alexander Le Mat	June 7, "
24,942	Lewis and Pflegar	Aug. 2, "
26,641	Gruler and Rebety	Dec. 27, "
27,518	W. H. Bell	Mar. 20, 1860.
27,868	F. D. Newbury	Apr. 10, "
28,331	Savage and North	May 15, "
29,213	C. R. Alsop	July 17, "
29,538	C. R. Alsop	Aug. 7, "
29,864	J. M. Cooper	Sept. 4, "
30,260	Aug. Spellier	Oct. 2, "
30,494	F. D. Newbury	Oct. 23, "
30,602	John Adams	Nov. 6, "
30,843	E T. Starr	Dec. 4, "
32,333	C. R. Alsop	May 14, 1861.
32,685	J. A. De Brame	July 2, "
33,770	C. H. Alsop	Nov. 26, "
33,932	W. H. Elliot	Dec. 17, "
34,032	Thomas Shaw	Dec. 24, "
34,093	W. J. Pitt	Jan. 7, 1862.
34,226	C. R. Alsop	Jan. 21, "
34,803	C. R. Alsop	Mar. 25, "
35,052	J. A. Whalen	Apr. 22, "
35,404	A. C. Vaughan	May 27, "
35,999	G. W. B. Gedney	July 29, "
36,861	H. S. Rogers	Nov. 4, "
37,004	T. J. Mayall	Nov. 25, "
37,329	F. Beals	Jan. 6, 1863.
37,921	S. Remington	Mar. 17, "
37,961	A. Hall	Mar. 24, "
38,336	James Reid	Apr. 28, "
38,934	L. W. Pond	June 16, "
39,409	James Kerr	Aug. 4, "
39,771	C. W. Harris	Sept. 1, "
39,825	Mershon and Hollinsworth	Sept. 8, "
39,869	J. H. Vickers	Sept. 8, "
40,021	J. M. Cooper	Sept. 22, "
40,553	J. W. Cochran	Nov. 10, "
41,184	D. Williamson	Jan. 5, 1864.
41,803	S. W. Wood	Mar. 1, "
41,848	B. Kittredge	Mar. 8, "
42,435	Thomas Gibson	Apr. 19, "
43,709	Robitail and Dahis	Aug. 2, "
44,303	S. Guilbert	Sept. 20, "
44,363	S. W. Wood	Sept. 20, "
45,290	R. White	Nov. 29, "
45,532	E. T. Starr	Dec. 20, "
46,131	F. D. Newbury	Jan 31, 1865.
46,612	C. E. Sneider	Feb. 28, "

1. *Chambered Cylinder revolving on Parallel Axis.* (*a.*) *Behind a Barrel; Cylinder charged at Front.* — Continued.

No.	Name.	Date.
47,707	W. H. Elliot	May 9, 1865.
47,712	G. H. Gardner	May 16, "
48,287	B. F. Joslyn	June 20, "
51,628	E. T. Starr	Dec. 19, "
51,690	G. C. Bunsen	Dec. 26, "
52,105	S. W. Wood	Jan. 16, 1866.
53,955	G. S. Crowell	Apr. 17, "
55,743	William Tibbals	June 19, "
56,466	William Tibbals	July 17, "
*65,742	E. J. Frost	June 11, 1867.
66,542	R. White	July 9, "
72,844	J. Gordon	Dec. 31, "
82,258	F. A. Thuer	Sept. 15, 1868.
99,893	B. R. Hill	Feb. 15, 1870.
109,914	Linberg and Phillips	Dec. 6, "
112,471	E. S. Leaycroft	Mar. 7, 1871.
112,472	E. S. Leaycroft	Mar. 7, "
115,258	E. Whitney	May 23, "
129,334	J. Gordon	July 16, 1872.
134,442	O. Schneelock	Dec. 31, "
142,376	B. K. Dorwart	Sept. 2, 1873.

1. (*b.*) *Behind a Barrel; Cylinder charged at Rear.*

12,648	R. White	Apr. 3, 1855.
15,032	F. B. E. Beaumont	June 3, 1856.
19,961	R. White	Apr. 13, 1858.
20,607	F. H. Harrington	June 15, "
21,400	E. Allen	Sept. 7, "
22,005	E. Allen	Nov. 9, "
22,348	E. Claude	Dec. 21, "
24,656	Smith and Wesson	July 5, 1859.
24,726	Ells and White	July 12, "
26,919	Morris and Brown	Jan. 24, 1860.
27,526	J. M. Cooper	Mar. 20, "
28,437	A. J. Gibson	May 22, "
28,951	E. Allen	July 3, "
29,123	A. J. Gibson	July 10, "
30,079	D. Moore	Sept. 18, "
30,245	E. A. Prescott	Oct. 2, "
30,309	A. J. Gibson	Oct. 9, "
30,765	C. Sharps	Nov. 27, "
30,990	Smith and Wesson	Dec. 18, "
33,328	Ethan Allen	Sept. 24, 1861.
33,509	E. Allen	Oct. 22, "
33,836	H. Gross	Dec. 3, "
34,016	A. Smith	Dec. 24, "
34,067	D. Moore	Jan. 7, 1862.
34,703	C. E. Sneider	Mar. 18, "
34,922	C. Draeger	Apr. 8, "
35,067	E. Allen	Apr. 29, "
35,419	C. W. Hopkins	May 27, "
35,623	L. W. Pond	June 17, "
35,657	J. H Vickers	June 17, "
36,505	C. C. Brand	Sept. 23, "
36,934	S. W. Wood	Nov. 18, "
37,004	T. J. Mayall	Nov. 25, "
37,059	J. Rupertus	Dec. 2, "
37,075	J. Jenkinson	Dec. 2, "
37,091	A. T. Freeman	Dec. 9, "
37,551	F. P. Slocum	Jan. 27, 1863.
37,693	J. C. Howe	Feb. 17, "
38,204	F. P. Slocum	Apr. 14, "
38,279	C. C. Brand	Apr. 28, "
38,321	D. Moore	Apr. 28, "
38,921	Smith and Wesson	June 16, "
39,318	Ellis and White	July 21, "
39,405	B. F. Joslyn	Aug. 4, "
†39,406	B. F. Joslyn	Aug. 4, "
39,619	S. W. Wood	Aug. 18, "
39,642	M. F. Geraghty	Aug. 25, "
39,645	H. Gross	Aug. 25, "
39,850	H. D. Ward	Sept. 8, "
40,687	E. H. Graham	Nov. 24, "
41,117	Briggs and Hopkins	Jan. 5, 1864.
41,857	W. Palmer	Mar. 8, "
42,379	B. F. Joslyn	Apr. 19, "
†42,688	H. Reynolds	May 10, "
42,823	D Williamson	May 17, "
43,529	R. D. O. Smith	July 12, "
44,126	W. Tileston	Sept. 6, "
44,953	F. W Hood	Nov. 8, "
45,176	H. Reynolds	Nov. 22, "
†45,912	W. C. Dodge	Jan. 17, 1865.
†45,983	W. C. Dodge	Jan. 24, "

1. (*b.*) *Behind a Barrel; Cylinder charged at Rear.* — Continued.

No.	Name.	Date.
46,023	R. H. Plass	Jan. 24, 1865.
†46,225	W. H. Elliot	Feb. 7, "
46,243	B. F. Joslyn	Feb. 7, "
46,562	P. Haughain	Feb. 28, "
47,252	A. Guerriere	Apr. 11, "
47,775	J. H. Vickers	May 16, "
48,287	B. F. Joslyn	June 20, "
†48,775	L. C. Rodier	July 11, "
50,224	S. Crispin	Oct. 3, "
51,092	Smith and Wesson	Nov. 21, "
†51,117	W. Mason	Nov. 21, "
51,269	J. Rider	Nov. 28, "
51,836	B. F. Joslyn	Jan. 2, 1866.
†51,985	E. Whitney	Jan. 9, "
†52,165	H. Hammond	Jan. 23, "
52,248	H. S. Josselyn	Jan. 23, "
52,582	B. T. Loomis	Feb. 13, "
53,539	W. Mason	Mar. 27, "
†53,548	P. Polain	Mar. 27, "
†53,881	S. H. Roper	Apr. 10, "
†54,065	J. B. Doolittle	Apr. 17, "
57,864	A. Christ	Sept. 11, "
59,629	A. L. Munson	Nov. 13, "
63,450	R. W. Drew	Apr. 2, 1867.
65,510	E. K. Root	June 4, "
75,016	G. Holman	Mar. 3, 1868.
85,350	J. Adams	Dec. 29, "
†93,572	R. White	Aug. 10, 1869.
†93,653	R. White	Aug. 10, "
†94,003	C. A. King	Aug. 24, "
97,780	F. A. Le Mat	Dec. 14, "
†99,505	R. White	Feb. 1, 1870.
†99,690	J. M. Marlin	Feb. 8, "
99,693	J. C. Miller	Feb. 8, "
100,227	R. White	Feb. 22, "
102,782	Felix and De Dartien	May 10, "
103,013	G. W. H. Calver	May 17, "
104,633	W. I. Page	June 21, "
†109,417	B. F. Joslyn	Nov. 22, "
†111,534	G. H. Harrington	Feb. 7, 1871.
113,053	S. S. Hopkins	Mar. 28, "
115,483	B. F. Joslyn	May 30, "
115,916	F. Wesson	June 13, "
116,078	Moss and Johnson	June 20, "
116,422	Forchand and Wadsworth	June 27, "
†116,559	F. G. Cochran	July 4, "
†116,593	F. W. Hood	July 4, "
†117,461	C. B. Richards	July 25, "
†118,752	C. Sharps	Sept. 5, "
119,048	C. B. Richards	Sept. 19, "
121,199	J. Rupertus	Nov. 21, "
122,182	T. Lee	Dec. 26, "
†128,644	W Mason	July 2, 1872.
†128,991	Wesson and King	July 16, "
132,357	J. Davis	Oct. 22, "
133,732	C. S. Wells	Dec. 10, "
135,377	O. A. Smith	Jan. 28, 1873.
135,378	O. A. Smith	Jan. 28, "
†136,134	W. Clews	Feb. 25, "
†136,348	D. B. Wesson	Feb. 25, "
†136,871	Smith, Smith, and Sweeney	Mar. 18, "
†137,043	D. Williamson	Mar. 18, "
137,968	O. A. Smith	Apr. 15, "
†133,047	G. W. Schofield	Apr. 22, "
139,461	C. Foehl	June 3, "
140,028	C. F. Galand	June 17, "
140,516	J. M Marlin	July 1, "
142,175	W. H. Philip	Aug. 26, "

1. (*c.*) *Cylinder without other Barrel* ("*Pepper-Box*").

....	B. and B. M. Darling	Apr. 13, 1836.
3,998	E. Allen	Apr. 16, 1845.
6,453	J. Post	May 15, 1849.
6,723	G. Leonard, Jr.	Sept. 18, "
6,925	Pecare and Smith	Dec. 4, "
7,300	D. H. Chamberlain	Apr. 23, 1850.
7,493	G. Leonard, Jr.	July 9, "
7,887	S. W. Marston	Jan. 7, 1851.
9,922	George Leonard	Aug. 9, 1853.
13,581	W. W. Marston	Sept. 18, 1855.
14,118	E. T. Starr	Jan. 15, 1856.
15,797	J. Adams	Sept. 30, "
21,188	W. H. Elliot	Aug. 17, 1858.
28,460	W. H. Elliot	May 29, 1860.

1. (c.) *Cylinder without other Barrel, etc.* — Continued.

No.	Name.	Date.
28,461	W. H. Elliot	May 29, 1860.
33,332	W. H. Elliot	Oct. 1, 1861.
39,032	J. C. Campbell	June 30, 1863.
42,648	W. H. Elliot	May 10, 1864.
43,606	J. Rupertus	July 19, "
51,752	J. Reid	Dec. 26, 1865.
57,448	J. H. Vickers	Aug. 21, 1866.
57,622	Converse and Hopkins	Aug. 28, "
84,976	F. Wesson	Dec. 15, 1868.

2. *Chambered Cylinder revolving on Vertical Axis behind a Barrel.*

183	J. W. Cochran	Apr. 28, 1837.
188	J. W. Cochran	Apr. 29, "
603	Haviland and Bennett	Feb. 15, 1838.
677	H. and C. Daniels	Apr. 5, "
7,218	H. Iverson	Mar. 28, 1850.

2. *Chambered Cylinder revolving on Vertical Axis behind a Barrel.* — Continued.

No.	Name.	Date.
12,235	E. H. Graham	Jan. 16, 1855.
14,780	S. F. Stanton	Apr. 29, 1856.
15,734	E. H. Graham	Sept. 16, "
16,477	H. Genhart	Jan. 27, 1857.

3. *Cylinder revolving on Horizontal Axis behind a Barrel.*

8,210	P. W. Porter	July 8, 1851.
10,944	E. H. Graham	May 16, 1854.
11,917	W. Wright	Nov. 7, "

4. *Revolving Hammer acting on several Stationary Barrels.*

6,960	C. Sharps	Dec 18, 1849.
17,386	W. W. Marston	May 26, 1857.
22,753	C. Sharps	Jan. 25, 1859.
42,698	E. T. Starr	May 10, 1864.

For illustrations of revolvers, see under the head REVOLVER.

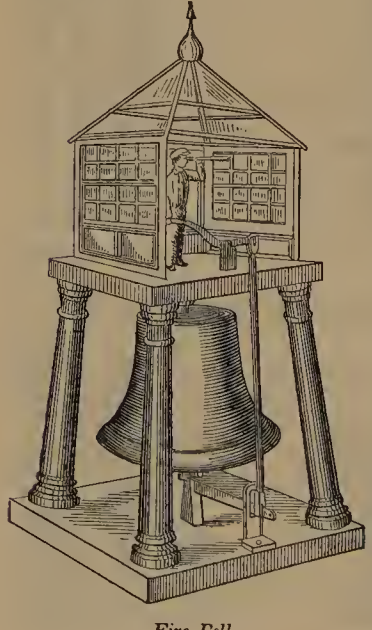
Fire-ar'row. An arrow carrying a combustible for incendiary purposes.

Fire-back. The back-wall of a furnace or fireplace. It is frequently of fire-brick, in order to protect the iron walls of the furnace, but is sometimes of iron ribbed, partly to protect and stiffen it and partly to allow access of air close to it. Sometimes the fire-back is perforated to admit air at that point; or it may be hollow, and form a heater for water for household purposes.

Fire-ball. A projectile of oval shape, formed of a sack of canvas filled with combustible composition. They are thrown into an enemy's works for the purpose of lighting them up, and are loaded with shells to prevent them from being approached. A wrought-iron bottom is attached to the bag to prevent breakage when discharged.

Fire-bal-loon'. 1. A balloon whose ascensional power is derived from a body of heated air rising from a fire beneath the open mouth of the bag. Montgolfier's balloon was of this kind. See BALLOON.

Fig 1985.



Fire-Bell.

2. A balloon sent up at night with fire-works.

Fire-bar. A grate-bar in a furnace resting on a frame, called the *fire-bar frame;* inside the *fire-box.* See GRATE-BAR.

Fire-bas'ket. A portable grate or cresset.

Fire-bell. A fire-alarm bell. One designed to indicate by a definite number of strokes the district or locality in which a conflagration is prevailing.

The illustration shows a striking-apparatus consisting of a series of levers connected with the clapper of the bell, and operated by a person stationed in a lookout-lantern above.

The signal-bells are now usually sounded by electricity. See FIRE-ALARM TELEGRAPH.

Fire-board. A board to close a fireplace in summer.

Fire-box. The fire-chamber of a locomotive-boiler. It is jacketed with a water-chamber to prevent radiation of heat. The fire-box door may also be double and have a circulation of water through the hinges. A *partition* in the box sometimes divides the fire-space into two parts, and, being full of water, increases the fire surface.

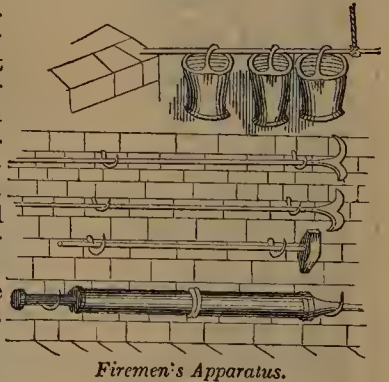
Fire-box stays are rods which prevent the crushing down of the top of the box by the pressure of steam.

Fire-brick. A brick of refractory clay for lining furnaces, ovens, etc. Fire-clay is a nearly pure silicate of alumina.

Fire-bridge. A plate or wall at the back of the furnace to support the ends of the grate-bars and prevent the fuel being carried over. It also serves to give an up turn to the flames against the bottom of the boiler.

Fire-buck'et. One made of canvas, leather, or wood, and kept in readiness for emergencies. On board ship, a fire-bucket has a sennit lanyard of a length regulated to reach the water alongside, from the station whence the fire-bucket is to be thrown overboard to be filled.

Fig. 1986.



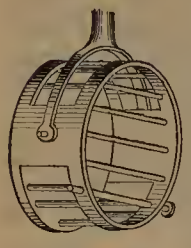
Firemen's Apparatus.

The illustration shows the firemen's apparatus of old time, — buckets, fire-hooks, hammer, and squirt.

Fire-cage. A skeleton box or basket of iron for holding lighted fuel. A *cresset.*

The form illustrated was invented by Dr. Franklin. The cage turns upon axes supported by a crotchet fixed on a stem. The stem may set in a step in the hearth, when used as a domestic grate.

Fig. 1987.



Fire-Cage.

or the fire-cage may be used for a beacon light. The fuel is introduced after withdrawing the upper bar, and when the kindling on top has begun to burn well, the cage is upset, bringing the lighted kindling to the bottom.

Fire-cham'ber. (*Puddling.*) The chamber at the end of the puddling-furnace, whence the flame passes to the reverberating chamber where the charge is placed.

Fire-cock. A street plug for attachment of hose for extinguishing fire, or for other municipal purposes.

Fire-damp A-larm'. One which indicates the presence of dangerous quantities of gas or fire-damp in coal workings. A *gas-alarm* or *gasoscope*.

Fire-dog. An ANDIRON (which see).

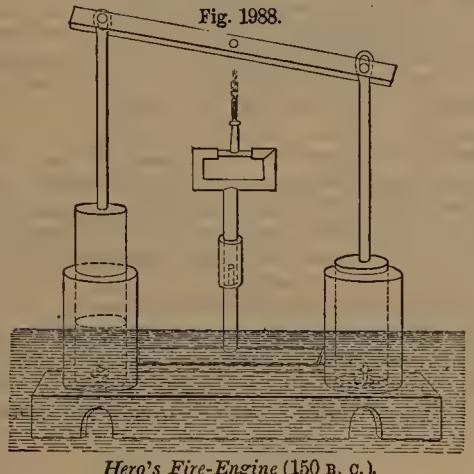
Fire-door. The door of a furnace; feeding and stoking are usually performed at the opening.

Fire-en'gine. A form of pump for throwing water to extinguish a fire.

The original fire-engine was probably a large squirt, the piston being worked by manual pressure, the barrel being filled from a tub after each discharge. In this form it existed till a late day.

The oldest known engine is described in the *Spiritalia* of Hero, about 150 B. C., and the description might stand for the ordinary form of hand-engine used at the present day. The drawing is made from

Fig. 1988.



Hero's Fire-Engine (150 B. C.).

the description. The engine had two single-acting pumps worked by one beam by means of brakes. The streams united in a common discharge-pipe passing up a trunk in which was an air-chamber and out at a nozzle which was capable of being presented in any direction.

The fire-brigade of Imperial Rome was a company of six hundred freedmen, organized by Augustus Cæsar, A. U. C. 732. A fire-preventive committee, consisting of seven freedmen and a president of the equestrian order, was organized fifteen years afterwards, say B. C. 7. Augustus gave the form stated to a preëxisting organization.

We do not find in any Roman writer a description of a machine so perfect as that of Hero. The *sipho* of the Romans is referred to by Pliny in a letter to Trajan: he states that the people of Nicomedia were too lazy to put out a fire in that city, and that they had no *sipho*. Strabo alludes to the *siphones*, which it appears were kept in a house, in preparation for accidental fire. Apollodorus, the architect of the bridge of Trajan across the Danube, mentions the *sipho*. Its construction seems to be unknown. Apollodorus recommends a leathern bag of water with hollow canes for discharging-nozzles.

The first notice of the modern fire-engine is in the Chronicles of Augsburg, 1518, which speaks of the "water-syringe useful at fires." They were mounted on wheels, and worked by levers. Similar devices are referred to by Lucar, 1590; Greatorix, 1656; and Morland, 1670.

The fire-engine of Nuremberg described by Caspar Schott, 1657, was of a different character. It was mounted on a sled 4 × 10 feet, and drawn by two horses. It had a cistern 2 × 8 feet and 4 feet deep, in which were two horizontal cylinders. The brakes were worked by twenty-eight men, and the combined streams from the cylinders issued at a one-inch orifice, and reached a hight of 80 feet.

An English patent appears of the date of 1632 to Thomas Grant, and one to John Van der Heyden (or Heide), of Amsterdam, 1663. He is credited with having brought the machine to the present modern form of hand-engine. The brothers Van der Heyden appear to have been the inventors of the leathern hose in detachable sections.

In 1699, a patent was granted in France to Duperrier for a *pompe portative* for extinguishing fires; to this Perrault added the air-chamber. Papin also adopted it. Hooks and fire-ladders must be assumed to have been long in use, but come into historic notice about this time. Fire-plugs were laid down in the streets of London in 1710; previous to that time the water was carried in buckets and poured into the fire-engine reservoirs.

Much attention was drawn to the matter of fire-engines by the disastrous fire of London in 1666, and an act of Common Council was passed shortly after the event, compelling parishes and incorporated companies to maintain an efficient supply of "*buckets, hand-squirts*, and *fire-engines*."

If we may judge by the description in Clare's "Motion of Fluids," 1735, some of the features of the Continental engines had not yet been received in England. He states: —

"Engines for extinguishing fires are either forcing or lifting pumps, and, being intended to project water with great velocity, their effect in great measure depends upon the length of their levers and the force with which they are wrought. A common squirting-engine, constructed on the *lift* principle, consists of a large circular cistern, like a great tub mounted on four small solid wheels. A perforated cover was fixed inside the cistern about three feet from the bottom. In the center was fixed a lifting-pump, to the piston-rod of which was attached a cross-tree carrying two vertical connecting-rods, which were simultaneously worked up and down by manual labor by means of handles on opposite sides of the machine. During the downward motion of the piston a quantity of water passes through the valve on to its upper side, and, when the piston ascends, this water is projected with great velocity through a branch pipe provided with a flexible leather joint, or by a ball-and-socket motion, screwed on top of the pump-barrel. Between the strokes the stream is discontinued. The cistern is supplied by water-buckets."

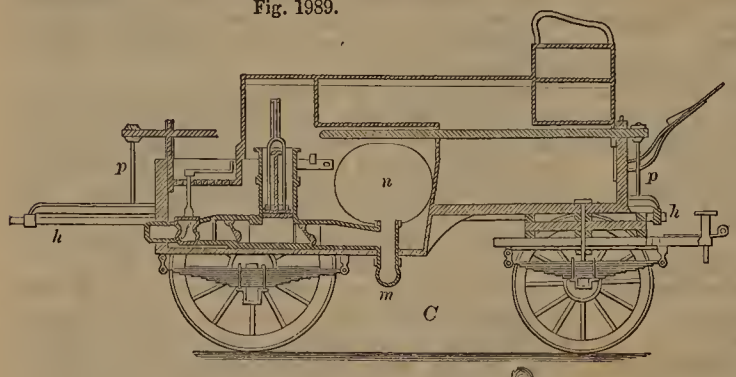
Towards the close of the seventeenth century the double-cylinder portable pump with air-chamber was introduced into England by Newsham; single-cylinder engines, like the modern garden syringe, being used in France and Germany, and credited to Duperrier and Leupold respectively.

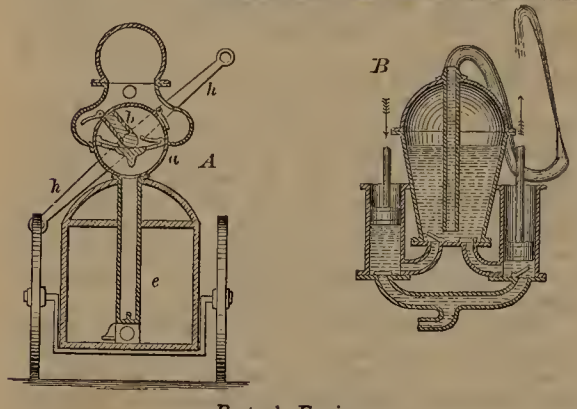
The Newsham engine was improved from time to time, retaining its main features, and was still in use in London till 1832, when it was superseded by

a more compact form, which was adapted to be drawn by horses, and from this period dates the efficient fire-brigade system of London.

Newsham's fire-engine was a side-brake double-

Fig. 1989.





Barton's Engine.

cylinder engine, mounted on four wheels, and with an air-chamber, goose-neck, and suction-pipe. The work on the brakes was assisted by men on the box, who threw their weight upon treadles on the pump-levers. Pumps were single-action force-pumps, worked by chains passing over segments on the pump-levers. The engine was perhaps the first successful fire-engine, and Newsham did very well by it. His patent was extended for a second term.

The engine which eventually superseded that of Newsham was made, rather than invented, by Simpkin, and patented in 1792.

The main improvement was in compactness and adaptation to traveling with speed to the spot where its services were demanded. The valves were contained in separate chambers, instead of being placed in the cylinders and air-chamber. By this means they were easily reached, without the disconnection of the main portions of the pump.

Another form of fire-engine was invented by Bramah, 1793, improved by Rowntree and eventually by Barton. The engine of the latter (*A*, Fig. 1989) was on the vibrating principle. To the levers *h h* was attached a radial piston *b*, which oscillated in the cylindrical chamber. As the piston moved in one direction, a valve beneath this piston opened to allow water to pass from the cistern *e*, and the water in front of the piston was forced through the valve-way above it into the air-chamber and passed out at the eduction-pipe to the hose. The difficulty with this engine, as with the rotary steam-engine and other pumps with annular chambers, was to keep the end and sides of the piston effectually packed.

B, Fig. 1989, shows the principle of the modern hand-worked fire-engine, which has two single-acting cylinders with induction-valves in the branches of a pipe which connects with the cistern or water-main; and eduction-valves in pipes which discharge into an air-chamber, whence the water passes by a hose to a nozzle.

C is the English form of hand fire-engine which has brakes *h* on side-levers *p*. The suction is united at *f*, and the discharge is at *m*; *n* is the air-chamber.

Steam-power for extinguishing fires was in use in manufacturing establishments many years before it was employed on portable machines. Every factory of any pretensions had its steam-driven pump, with hose and other attachments calculated to reach every portion of the establishment. About the year 1830, Captain Ericsson, then of the firm of Braithwaithe and Ericsson, London, England, built and exhibited a portable steam fire-engine. In 1842 or 1843 he produced a similar engine in New York City, and it was tested, but never brought into regular service. The engine delivered 9,000 gallons an hour to a hight of ninety feet through a $\frac{7}{8}$-inch nozzle. It was ignited at the station, and drawn by horses to the fire. The time occupied in getting up steam was eighteen minutes. The motion of the wheels worked the bellows to blow the fire in the furnace.

Cincinnati was the first city to adopt the steamer as a permanent portion of its fire-department force.

This was due to the inventive and constructive skill of the brothers Latta and Mr. Abel Shawk, supplemented by the foresight, persistence, and tact of Mayor Miles Greenwood, all of that city.

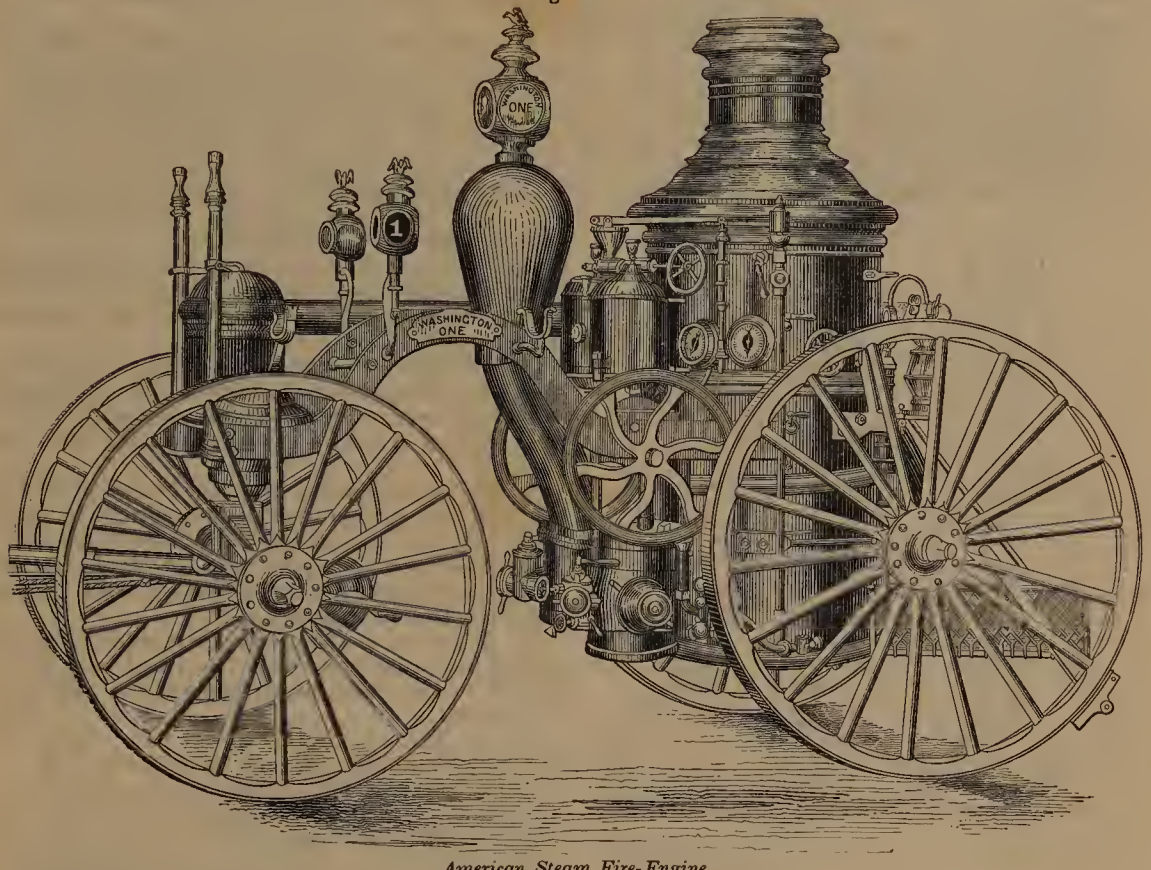
The metropolitan fire-department of New York City numbers 34 steamers of about 50-horse power each, equal to 185 men, or in the aggregate 6,290 men; while the actual number of men employed, even adding the 12 hook-and-ladder companies, is only about 550; thus relieving 5,740 men from the labors, dangers, and exposure of the fireman.

The Cincinnati engines and system are excelled nowhere, and have been copied into the principal cities of the world. The steamer "Citizens' Gift," one of the earliest of the Cincinnati steam fire-en-

Fig. 1990.

English Steam Fire-Engine.

Fig. 1991.



American Steam Fire-Engine.

gines, was built in 1853, and thirteen years afterward gave the following record: Time of raising steam, three minutes and forty seconds from the time the torch is applied until water is thrown from the nozzle; size of nozzle, 1½ inches; distance thrown, 310 feet, measuring from the end of the nozzle to the place where solid water fell; size of steam cylinder, 10 inches bore, 24 inches stroke; pumps, 6 inches bore, 24 inches stroke; double engine-cranks at right angles; large air-vessels, connected together; length of hose, 100 feet; steam, 100 pounds to the square inch; pressure on water cylinder, 240 pounds to the square inch; speed of engine, 110 revolutions; 220 strokes of pumps; grate surface, 16 feet; heating surface, 560 feet.

The chemical fire-engine is one on the principle of the fire-extinguisher (which see), in which, by throwing a body of sulphuric acid on to an alkali, a body of carbonic acid is generated and ejected into the flame, usually in combination with a spray of water which is ejected from its reservoir by the pressure of the gas, or by the play of the pump-brakes.

In connection with this subject it may be stated that the rate of insurance by land and sea among the Hindoos was left to the custom of the trade, according to the risk. — *Institutes of Menu* A. D. 880.

Nicholson states that fire-insurance offices were first introduced under the reign of the Emperor Claudius.

The "Hand in Hand" Fire Insurance Company was the first established in London, 1696. The "Sun" Fire Insurance Company was established in 1700. *Marine* insurance had long been common in Venice. The "Amicable" *Life* Insurance Company of London was chartered in 1706.

Fire-insurance offices established in Paris, 1745.

Fire-es-cape'. Fire-escapes are divided into three classes: —

Ladders.

Portable escapes.

Carriage-escapes.

1. Fire-ladders are made of several lengths, to reach second, third, or fourth story windows, and are mounted on a suitable carriage for transportation. The upper ends are usually provided with hooks which catch against the building, on a window-sill, cap, coping, or cornice, and give some degree of security to the ladder.

Another form of the ladder is made of several sections, which may be united to form a ladder of any length required. The sections are united by tubular sockets or clasps.

Another form is that in sliding sections of gradually decreasing width, so that when packed the different sections form a nest of parallel lengths. The sections are slipped on each other by cogs and pinion or by tackle.

2. Portable escapes are those which are contained in a compact form to be raised and placed in position in an emergency.

Among these are —

A *knotted rope.*

Rope-ladders kept within the house and provided with a means for lashing to some stationary object in a room or on a staircase, while the ladder itself depends from the window,

Wire or *chain ladders*, on the same principle, are compact and strong, not subject to decay or to be burned away when in position.

Both descriptions of ladders are also made with grapnels, so arranged as to be elevated from the outside and attached to a window-sill for the escape of the occupants of the house.

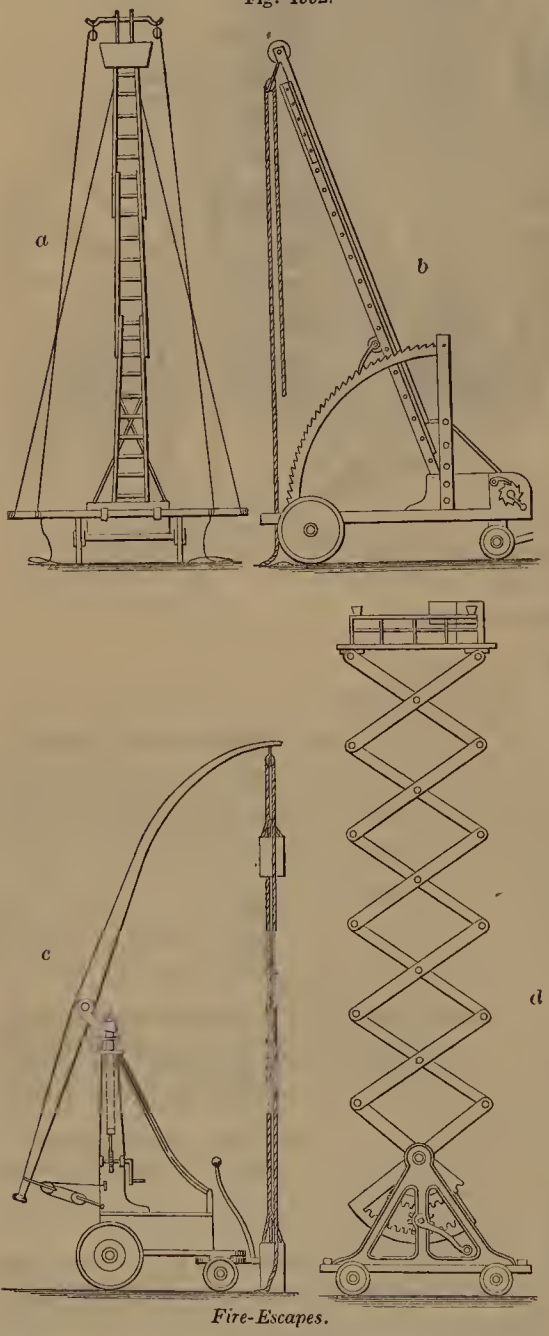
Slings are used, and forms of tackle.

One sling has the bight of the rope secured be-

neath the window-sill and the ends held apart by persons in the street. A clasp is buckled to the person and slides on both ropes, the descent being checked by the divergence of the ropes.

Of forms of tackle, one is the single whip, the person sitting in a sling at one end and veering out the fall through his hands. In another form the person sits in a sling suspended from the bight of a rope, and lowers himself by allowing the rope to

Fig. 1992.



Fire-Escapes.

veer through the holes of a block, like a euphroe. It is a tackle with dead-eyes instead of sheaves. It is mentioned in Rees's Encyclopedia.

The Edinburgh (Scotland) fire brigade is furnished with cross-bows and three-ounce leaden bullets to which are attached fine cords 130 feet long. The bullet is fired over the house, and persons in the rear of the building pull at the cord to raise a stronger one from which a chain or ladder or escape is suspended. The men are regularly trained to the exercise.

Of carriage-escapes four types may be cited, but room cannot be spared for a treatise. They may be called the *extension-ladder* with guys and stays, *a;* the *ladder with segment rack*, *b;* the *boom* or *crane*, *c;* and the *lazy-tongs*, *d*. The cuts will be understood without lengthy description.

Fire-ex-tin'guish-er. A portable apparatus for extinguishing fires either by ejection of water, saline solution, or carbonic-acid gas.

1. The vessel contains chemicals whose reaction, when brought into contact, releases a gas which presses upon the surface of the water and ejects it at the nozzle.

a. The chemicals may be contained in two chambers; inversion of the apparatus or the breaking of a bottle of acid mixes the ingredients, and the chemical reaction evolves a gas which presses upon the water.

b. The chemicals may be mixed in the water and generate the pressure which is immediately available when the nozzle is opened and air admitted.

c. The water is saturated with gas, in the manner of the soda-fountain, so as to forcibly expel the water when the outlet is opened.

d. A body of mechanically compressed air is contained in a compartment of the vessel, and is admitted to the water, when required, by turning a stop-cock.

2. *a.* The receptacle contains two vessels, one of which is usually a salt and the other an acid.

When it is to be brought into play a plug is driven in, which breaks the bottle containing the acid and allows it to flow over the salt of soda, potash, magnesia, or ammonia, as the case may be, the evolved carbonic-acid gas flowing in volumes from the nozzle of the vessel.

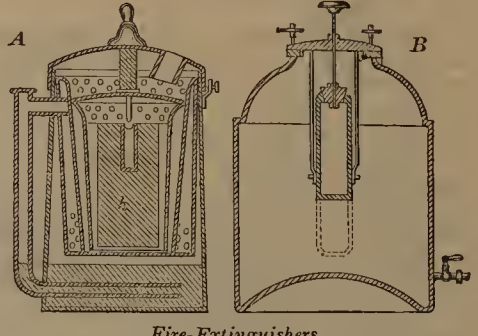
The acid used is usually sulphuric, but hydrochloric and tartaric are occasionally employed.

The salt is a carbonate of an alkali; soda, potash, ammonia, or magnesia being employed, as just stated. Other combinations of salts, chlorides, and sulphates, are employed.

In some of the apparatus, water is ejected along with carbonic acid; in others, sufficient heat is generated to evaporate the water, and steam is ejected with the gas.

b. The vessel contains inflammable substances

Fig 1993.



Fire-Extinguishers.

which generate carbonic acid when air is admitted, and eject the gas in volumes.

The chemicals used are phosphate of lime, nitrate and chlorate of potash, carbon, sulphur, and various other materials in a multitude of combinations.

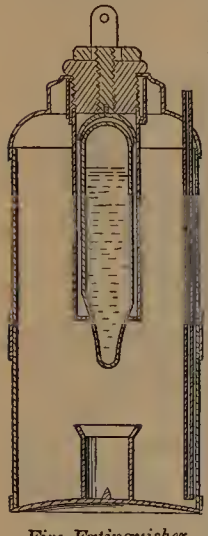
There are perhaps sixty patents for various forms of the *fire-annihilator*. The devices particularly refer to the modes of construction, the acid and alkali

chamber, the modes of precipitating the former upon the latter and availing the product. The Phillips *fire-annihilator*, so called, patented in 1849 and shown at *A*, has a compound of sugar and chlorate of potash so placed as to receive the contents of a bottle of sulphuric acid which is broken by striking a plug on the top of the can when a fire occurs. The mass of salt and sugar *h* is in the inner chamber, and the vial of acid imbedded in it, so as to be broken by a blow on the central plunger, when the lid is taken off for that purpose. Around the perforated case containing the filling *h* is another one, and that is in a third, between which and the outer one is a body of water. The carbonic acid produced by combustion passes out of the top of the machine, meeting, on its passage out, with the water which is raised in the side pipe by the pressure and heat of the combustion in the can, thus saturating the gas.

The — so-called — *American* fire-extinguisher has a cylinder containing bicarbonate of soda in solution, and an interior tube, containing crystallized tartaric acid, the whole being hermetically closed, but a communication left at the bottom of the tube, through which a reaction takes place, gradually converting the bicarbonate into tartrate of soda, and liberating the carbonic acid. This reaction being complete, the apparatus is ready for use, and on opening a cock at the bottom, the contents can be violently ejected through a short hose.

The *Gardner* consists of two cylinders, in one of which is diluted sulphuric acid, and in the other the aqueous solution of bicarbonate of soda. When the apparatus is required for use, connection is made by opening cocks between these two cylinders and a drum below them, into which the liquids flow, and where the carbonic acid is liberated, and the necessary pressure acquired to throw a jet through the hose.

Fig. 1994.



Fire-Extinguisher.

The machine shown in Fig. 1994 contains acid in a glass bottle, which is shattered by dropping upon a stud when forced below the flanges of the tin cylinder which holds it.

The *National* has a glass tube which contains the sulphuric acid. It is protected from accidental shocks by a metallic tube which surrounds it, and which is perforated to permit the free passage of liquid through its walls. When the apparatus is to be used, a piston is screwed down upon this glass vessel, crushing it, and permitting its contents to escape.

The *Babcock* (*B*, Fig. 1993) contains the sulphuric acid in a leaden bucket, hung upon trunnions below its center, so that, if set free, the bucket immediately turns upside-down. It is kept rigidly upright, however, by a stopper attached to a rod passing through the cap of the apparatus. This stopper also completely prevents communication between the acid and the alkali. When the extinguisher is to be used, the stopper is pulled up by means of an exterior handle; the bucket instantly turns over, and empties itself into the liquid in the cylinder.

In another form, the machine is set in operation by tipping. Another is set in action by a fuse tipped with a substance ignited at 120° F., or some other degree, as may be thought desirable. The apparatus is mounted on a carriage to operate on a larger scale.

A different description of fire-extinguisher consists of an arrangement of pipes throughout a building, so arranged as to throw water into the apartments and on the walls, when the water is turned on. With some of these arrangements the water is contained in cisterns on the roof; in others the pipes are connected with the water-distributing mains of the town.

An early instance of the kind is the English patent of Sir William Congreve, dated February 7, 1809, and No. 3201. In it almost all the more modern devices of this kind are shown. The perforated pipes run along the cornices and ceilings, the showers or jets proceed from center to circumference and conversely. On the chandelier pendant rotates a rimless wheel whose spokes distribute jets of water.

The apparatus is actuated by the heat of the room by means of fusible matters, such as wax which melts at 92° F., or a trinary alloy of lead, tin, and bismuth, which melts at 190°. An arrangement is also described by which the rising of the column in the mercurial thermometer is made to set the apparatus at work.

The general discharge may be made by a person in any one of the rooms of the building so furnished.

A common form has a cistern on the roof, central vertical trunk, and radiating pipes with jet-holes. See Fig. 1982, under FIRE-ALARMS. Modern patents concern mere details.

Fire-fan. A small blast apparatus adapted to a portable forge, or one — say a locksmith's — which has small proportions.

Fire-gild'ing. The mode of gilding in which the gold is put on in the form of an amalgam and the quicksilver afterward driven off by heat.

Fire-guard. A wire frame placed before an open fire to arrest sparks and burning coals. See FENDER.

Fire-hook. 1. A large hook on the end of a pole for tearing down buildings on fire, or to arrest a fire.

2. (*Steam-engineering.*) A kind of hook for raking and stirring the furnace fire.

Fire-i'rons. The implements for tending a fire. Poker, tongs, and shovel.

Fire-lad'der. These were introduced, as a part of the machinery for extinguishing fires, about 1672. They seem to have originated in the Netherlands.

Many and ingenious have been the devices for enabling the firemen to reach the scene of conflagration, and to pour in the jet of water at close quarters or into a part of the building which cannot be reached from the ground. Experienced men seem now to have settled down upon a set of ladders of varying length for different occasions, and mounted upon a long carriage drawn by a pair of horses.

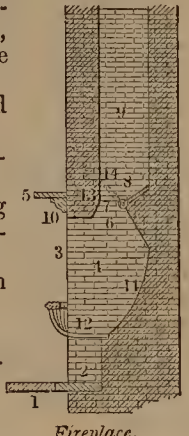
Some forms of ladders are cited under FIRE-ESCAPE (which see).

Fire-lock. A musket or military rifle. See FIRE-ARM.

Fire-pan. A pan for holding fire. The pan which held the priming of the old flint-lock gun.

Fire'place. That part of a room in which the fire is built.

Fig. 1995.



1, slab.
2, hearth.
3, jamb.
4, fireplace.
5, mantel-piece.
6, throat.
7, gathering.
8, funnel.

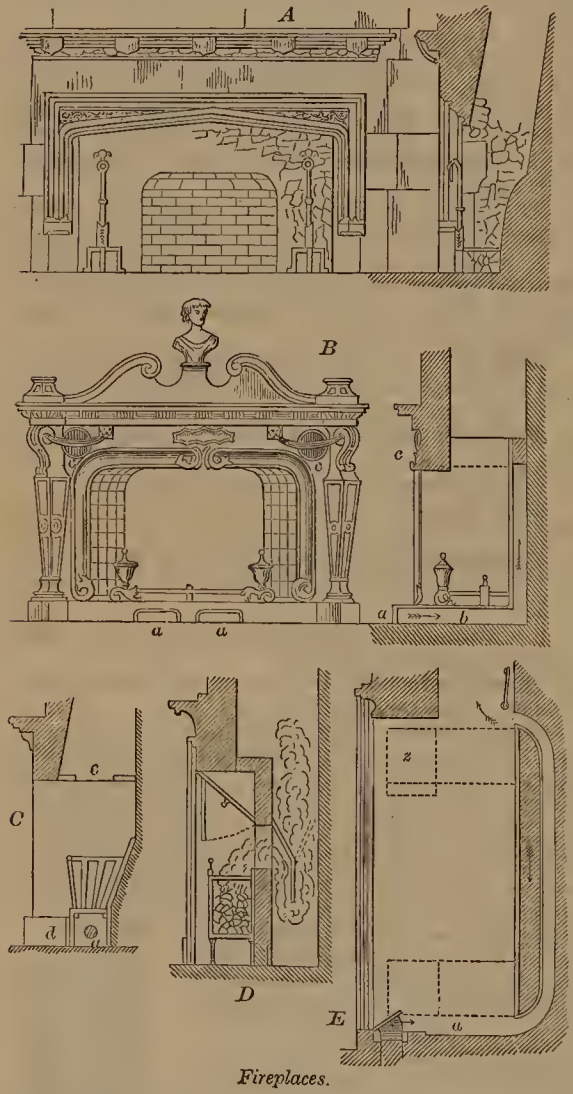
Fireplace.

9, flue.
10, mantel.
11, back.
12, grate.
13, breast.
14, damper.

The earliest example of a fireplace cited in this work is that of Coninsborough Castle, in England, of the Anglo-Norman period. The mantels are constructed of flat arches. The example is adduced to show the earlier form of chimney, and perhaps the most ancient one in existence, anticipating by several centuries the first chimneys erected in Italy. (See CHIMNEY.) The fireplace (*A*, Fig 1996) in the hall of Vicar's Close, Wells, England, is an example of the fireplace of some centuries back.

Louis Savot, of the Faculty of Medicine at Paris (1579–1640), published a work on warming and

Fig. 1996.



Fireplaces.

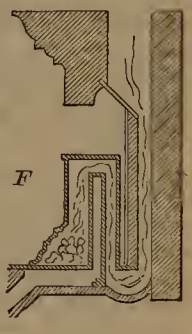
ventilation in 1624. His is the first recorded attempt at combining the cheerfulness of an open fire with the economy of an inclosed stove. Fig. *B* shows a front view and an elevation of his ingenious arrangement. The hearth, covings, and back were lined with thick iron plates three inches distant from the masonry. Air entered at *a*, passed along the chambers *b*, and entered the room at *c c*.

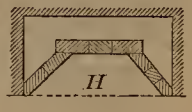
D is Prince Rupert's fireplace, somewhat celebrated in its time. It had a diving flue and false fire-back.

About 1658, Sir John Winter invented a coke furnace or fire-cage (*C*) which was placed on a close box about eleven inches high, in front of which was an opening *d*, fitted with a door, which always kept closed except when the ashes were being removed. A pipe *a* communicated with the external air, and was closed, when required, by a damper. When the valve was opened, a brisk draft urged the fire. The flue was closed by an iron plate or register at *c*.

Cardinal Polignac, in 1715, published under the name of another man (Gauger's "Treatise on the Art of warming Rooms") an account of improved mechanical arrangements for fireplaces. This is shown at *E* in the figure. The hollow metallic case forming the back of the chimney is divided into three or more caliducts which are not in contact with the back wall. The jambs are iron plates, solid backed. The channel *a* conducts the external air into the caliducts, which form a fire-back, and the warmed air escapes into the room at *z*. He also introduced the parabolic sides.

Fig. 1997.



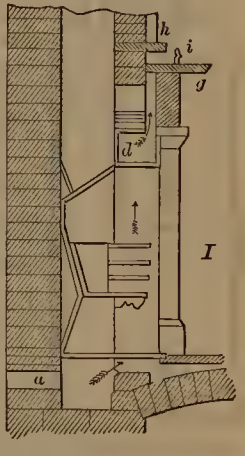


Rumford contracted the fire-chamber and throat, and inclined the jambs. See COVING.

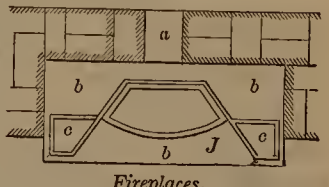
In 1745, Dr. Benjamin Franklin introduced a fireplace which he named the "Pennsylvanian," in which Prince Rupert's descending flue was combined with Polignac's caliducts. This is shown at *F*. (Fig. 1997.)

Count Rumford's improvements consisted mainly in the contraction of the chimney at the throat, the rounding of the breast-work, and the flaring of the covings, as illustrated in the accompanying plan and section *G H*. He preferred an angle of 45° for the covings.

Arnott also made himself a name in this line.



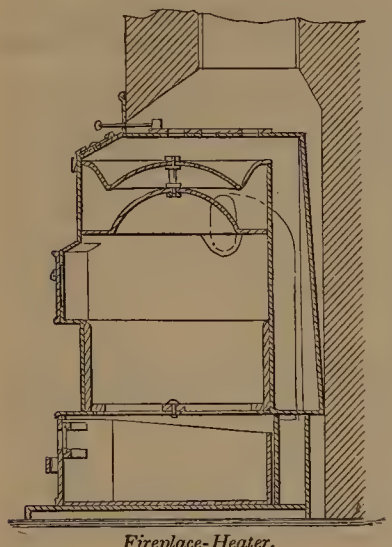
I J are a vertical section and plan showing an English tubular fireplace designed to warm a current of pure air derived from the outside, and direct it into the interior of a room; the air passes from the flue *a* to the under side of the hearth-plate *b* (shown in the plan), thence upward through the upright tubes at *c c* to a horizontal tube *d* (shown in the elevation), which has an opening through its entire length on the upper side, whence the hot air passes into the room, through the aperture *h i* over the mantel. The supply of air may be regulated by moving the strip *i* — which directs the air upward — nearer to or farther from the ledge *h*.



Fireplaces.

Fire'place Heat'er. A stove or closed grate set within or principally within the fireplace, and

Fig. 1998.

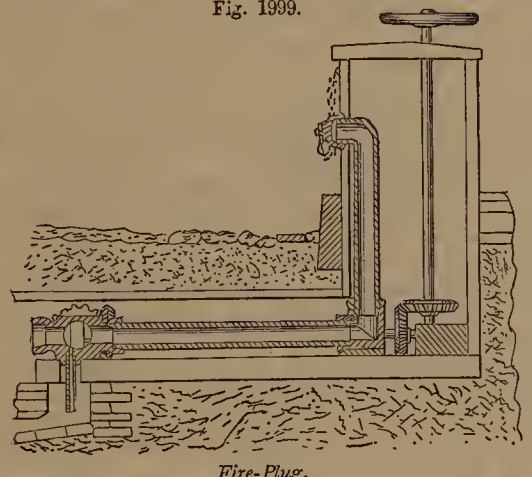


Fireplace-Heater.

serving to warm the room, the pipe discharging into the chimney. The kind known as the Latrobe is a base-burning fireplace-heater whose pipe passes up the brick flue to heat the air which passes between the pipe and the flue to the rooms above, into which it passes through registers.

Fire-plug. A device for connecting a fire or watering hose with a branch from a main. It usually consists of a screw nozzle to which the hose may be coupled, and a key and rod by which the valve is moved. In the example, at the point where the branch pipe is coupled to the main, the stop-cock is placed, and it is operated by gearing and

Fig. 1999.



Fire-Plug.

connecting shafts from a hand-wheel in the vicinity of the plug.

Fire-pot. 1. The box or pot in a stove which holds the fuel. Especially applied to a frustum of a hollow cone or conoid, used in base-burning and other heating stoves (which see).

2. A crucible. In various metallurgic operations the crucible is always termed the *pot*.

Fire-proof Fab'ric. The term *incombustible cloth* was originally applied to fabric made of asbestus, which was used among the ancients to a considerable extent. See ASBESTUS.

Cloth or wood impregnated with certain saline substances will not blaze. Borax, alum, and phosphate of soda or ammonia are recommended as most suitable for this purpose.

By treating cloth with graphite in a bath in which the mineral is suspended, and then subjecting it to the action of the electro-metallic bath, the cloth may be coated with metal.

The chemists who experimented on this subject by direction of Queen Victoria recommend "a concentrated neutral solution of tungstate of soda, diluted with water to 28° Twaddell, and then mixed with three per cent of phosphate of soda." Tissues dipped in this fluid may char or shrivel, but they will not blaze.

Woolen and ordinary stuffs may be treated with borax, alum, or soluble glass, but these cannot well be applied to the lighter descriptions, which are most liable to take fire.

A weak solution of chloride of zinc has long been employed by stage-dancers to render their dresses incombustible. M. Lunere recommends adding to the starch with which the material is done up, half its weight of chalk, and M. Patua proposes a solution of 4 parts borax and 3 sulphate of magnesia, in 20 to 30 parts water. By a new process, equal parts of chloride of calcium and acetate of lime are combined, forming crystals, which is mixed with the starch used in stiffening.

Though not strictly coming under the denomination of fire-proofing, an interesting fact is stated by M. Corne in a communication addressed to the Academy of Natural Sciences, that by previously dipping the hands in liquid sulphurous acid, they may then be immersed in melted lead or iron with perfect impunity. This is owing to the extremely volatile character of the acid, which has been made use of in the curious experiment of freezing water in a red-hot crucible.

Fire-proof Safe. One for the safe keeping of valuables for protection in case of the burning of a building in which they are placed. See SAFE.

Fire-proof Struct'ure. A vault, safe, or building proof against destruction by fire, either from the outside or by the burning of its contents.

The provision against outside fire is the usual object, but in fire-proof structures the internal floors or partitions must also be impenetrable by fire, to make the building technically *fire-proof*.

The principal portions of a building are the walls, floors, and roof, and several modes of constructing each have been proposed, to the end that they may be secure from fire.

The term *fire-proof building* is somewhat loosely applied, and may be held to mean, —

A building absolutely incombustible, such as one whose walls, floors, and roofs are of metal, stone, brick, or cement.

A building capable of opposing the access of fire from without, having walls, window shutters, and roofs which are incombustible from external flame and heat.

Among the first instances may be cited some government buildings, whose walls are of stone and brick, ceilings and floors of brick arches and pavement; or of metal, brick, and cement; rafters and roof-covering of metal, or metal and slate.

The Bogardus buildings of cast and wrought iron, and the Paxton buildings of iron and glass, are other illustrations of fire-proof structures, unless the amount of combustibles contained should be such that their conflagration will melt or crumble the material of which the building is constructed. Such was the case with a part of the Crystal Palace at Sydenham, the internal fittings of that portion, the louver boarding, and the furniture making a bonfire which melted the skeleton frame. Iron buildings in serious external fire exposure, or with combustible contents, are far from deserving the name of fire-proof, though they may resist a certain amount of scorching.

The usual mode of making fire-proof floors is to construct girders and beams of iron (see BEAM), supporting flat arches of brick, as in the U. S. Treasury, Medical Museum, and other government

buildings, or of a pavement of stone slabs resting on flanges of the beams. The ceiling in such a case may be of plaster on lath made of hoop-iron or wire-work riveted to the beams. See FLOOR; LATH.

Many European buildings are thus constructed, being filled above the arches with incombustible rubbish, and the tiled floor laid in cement thereupon.

Besides the projects for rendering materials fire-proof, a number of plans have been devised for adding to the security of a building, although the structure cannot be considered as actually *fire-proof*. Some of these may be mentioned.

The floors of some Edinburgh houses are of plank two and a half or three inches thick, grooved and tongued to each other or united by a fin of metal forming a tongue which runs the entire length. The planking is fitted air-tight to the walls, the object being to prevent the passage of fire, and depend upon the thickness of the flooring to hold fire at bay in a given part of the building, until the usual means of extinguishing it can be brought to bear. It is laid on iron joists. Cement on the upper and lower surfaces adds to the security. This is an excellent plan.

Another plan is to form the floors and roofs of hollow earthenware tubes and cement, resting upon joists or rafters, as the case may be. The tubes are made square in section. The floor has about one fifth the weight of stone. Frost's cement of levigated chalk, 2 parts; clay, 1 part; dried, broken, burned, and ground to powder. This is an approach to the pozzuolana, and is mixed with twice its quantity of sand and water, sufficient to form a mortar. See CONCRETE; CEMENT.

There are various concretes which may be made into slabs, capable of resting upon iron beams at the usual distance, and thus form a perfectly fire-proof floor.

It should be mentioned as an imperative necessity that the staircase should be absolutely incombustible, of metal or stone, or the two combined.

When a building has some of the *protections* against fire, without being absolutely *proof*, the stairs and hatchways must be inclosed in such a manner as not to be involved by a fire breaking out on any of the floors. Otherwise the vertical shaft forms the best possible means of communicating fire from one portion to another, especially if the fire be low down in the building.

Other plans are, —

Iron facing for walls; secured by anchors or studs. Iron skeletons filled with brick or concrete. Concrete or béton walls. Hollow tile walls. Iron frame with wire-work riveted thereto and covered over with plaster or concrete. See WALL, where many varieties are illustrated.

The means for fire-proofing the necessary openings, that is, the door and window ways, are by louvers, folding, sliding, swinging, and rolling shutters of iron. Some made double with intervening air-space; others made to close automatically by the increase of heat when exposed to fire.

Hartley's patent, 1775, consisted of a plan for sheathing wooden work with thin iron plates.

Earl Stanhope's plan was to pack all the interspaces of wood-work with incombustible material; preferably concrete.

Of other English plans of late date may be cited, iron joists with concrete filling and upper bed supporting the flooring. See FLOORING, where several varieties are shown.

Another plan is cellular joists of earthenware tubes imbedded in cement.

Loudon recommends a floor of cement with imbedded ties of wrought-iron rods, supported by pillars at intervals; and double sides of concrete supported by panels or lattice, leaving intervening spaces between walls.

In large fires, cast-iron is found to be a treacherous and destructible material, as was proved in Chicago, Boston, and elsewhere, fairly melting in the fire. Mr. Braidwood, of the London Fire Department, stated that iron columns were liable to give way suddenly, owing to the expansion and contraction by heat and jets of water. Mr. Mullett, the supervising architect of the Treasury Department, indorses the statement, and prefers sound oak timber to cast-iron, especially if it be treated with a liquid silicate.

Fire-proofing by rendering the timber of the structure incombustible has been frequently attempted. Payne's process consists of immersion in a solution of barium or calcium. Professor Fuchs of Munich recommends as a material for rendering wood fire-proof a composition of potassa or soda, 10 parts; siliceous earth, 15 parts; charcoal, 1 part, fused and formed into a water-glass and applied in solution. It forms a vitreous coating.

An English composition is as follows: Fine sand, 1 part; wood ashes, 2 parts; slaked lime, 3 parts. Grind in oil, lay on with a painter's brush, the first coat thin and the next thick.

Fire-proofing may be said to be accomplished when — 1, the building is of a material which neither burns, melts, cracks, nor crumbles with the heat. Well-made, homogeneous, and well-burned bricks are the best. Granite, marble, and sandstone perish by the heat.

2. Every opening communicating with the external atmosphere must be kept closed with fire-proof doors and shutters, not iron merely, which will buckle up, warp, and melt.

3. The walls must be of sufficient thickness, and should be built with an air-space to prevent the transmission of heat.

4. The joists should in no case be carried into the walls, but should be supported on corbel courses of brick, and connected with the walls themselves only by wrought-iron anchors.

5. The windows and doors to be protected, as before said, with fire-proof shutters, and the roof to be of slate or metal. The use of roofs composed of shingles, coal-tar, or other similar substances, should be prohibited by law in cities.

6. An isolated stone or iron staircase should reach every story, having fire-proof doors at each floor, and a line of water-pipes communicating with the mains in the streets or a cistern on the roof.

7. Partition-walls between houses rising above the roof. In the case of warehouses, as few openings through the party wall as possible, and these capable of being closed effectually.

A refinement upon the brick construction consists in using fire-brick with joinings of fire-clay, instead of mortar or cement; and the isolation of rooms instead of floors only is recommended in a report to the London Society of Arts; farther, to have no opening into the rooms except to external fire-proof corridors on each story; ascended by circular stairways. Doors, shutters, as well as walls, floors, and roof, to be of fire-brick, making each room an hermetically sealed vault.

For the purpose of extinguishing fire in any of the apartments, it is proposed to lay tubes of fire-clay in the spandrels of the building with small jet tubes, or pipes, commanding each room or corridor of the whole warehouse, so that the water can be turned on to any part required, to flood if necessary

the entire room. In such case the water would run down the walls to the floor, where, by a system of pipes leading to the main sewer, the proper drainage would be effected. It is also proposed to open and shut all the doors and shutters, and work all the cranes by machinery in another building to be under the supervision of a watchman, properly instructed, and competent to see that the system is in working order at all times. The same system of piping used to extinguish fires may also be used to cleanse the rooms, as occasion may require.

This system of protection against loss by fire, or rather mode of overcoming fire, by abundant ramifications of water-pipes throughout all the apartments and passages of a house, as well as upon the roof and walls, is thoroughly described in Sir William Congreve's English patents, No. 3201 of 1809, No. 3606 of 1812, and there seems but little to be added to his proposals where jets are by the turning of a plug caused to issue from center-piece, cornice, skirting-board, eave, comb, gable, and everywhere else. As this was before the era of water-mains, except in a few situations, the proposed supply was brought from cisterns on the roof or from pumps, and each floor or gallery had plugs by which the system of pipes of the respective stories were supplied.

A large flax-manufactory, to be run by steam-power, was erected about 1790, by Mr. Bage, at Shrewsbury, England. It was four stories high; the floors of brick arches were supported on cast-iron columns. The roof was also of iron.

Fire-reg'u-la'tor. A thermostatic device to open or close the access of air to the fire, or to govern the draft-area in the chimney, in order to urge or moderate the fire as it may sink below or rise above the desired point to which the thermostat is adjusted.

Fire-screen. 1. A fire-guard or *fender*.

2. A screen to place between a person and the fire to intercept the direct rays.

Fire-shield. A portable structure on wheels or on legs, used to protect a fireman on duty from the heat of a burning building, or to isolate a fire and prevent its spreading to adjacent buildings. It is usually a screen of sheet-iron supported by posts and stayed by guys.

Fire-ship. A vessel freighted with combustibles and explosives, and turned adrift so as to float among the vessels of the enemy, against a bridge or other object which may be burned by the fire or destroyed by the resulting explosion.

Fire-ships were used at the siege of insular Tyre.

By the Rhodians against the Syrians, 150 B. C.

In the action near Carthage, when the fleet of Basilicus was destroyed by Genseric.

In the naval warfare of the Knights of Malta and the Turks.

At the siege of Antwerp, 1585. By Sir Francis Drake against the Spanish Armada, 1588.

By the Greeks against the Turks, 1826.

The Chinese against the English in the villainous opium-war.

In 1760 they formed a regular portion of the British navy. As a distinct class of vessels, they are now discontinued.

They are particularly serviceable in defence and in attacking ships at anchor, and besides the skillful but ineffectual use of them by the Chinese, the instance may be mentioned of the fire-rafts which were launched by the Confederate forces against the approaching fleet of Farragut as he forced the passage of the Mississippi.

Fire-steel. A steel used in connection with a flint for striking fire.

Fire-stop. The fire-bridge at the back of a furnace; so called because it prevents coals being pushed over.

Fire-sur'face. (*Steam-engine.*) The area of surface of the boiler which is exposed to the direct and radiant action of the flames.

The heating-surface of a boiler is made up of the *fire-surface* and *flue-surface*.

With an average boiler 15 feet of heating-surface of the boiler are allowed for each horse-power. The Cornish engine has a much larger heating-surface per horse-power; as high as 60 feet being sometimes allowed.

The locomotive has a smaller heating-surface per horse-power, a more intense fire being kept up and less economy of fuel being practiced.

Fire-tel'e-graph. See FIRE-ALARM TELEGRAPH.

Fire-tube. (*Steam-engine.*) A furnace-tube through which the flame and heated air pass from the fire-chamber. A *flue*; a *pipe-flue*; or *flame-tube*.

Fire-work. The Chinese led the world in this line in point of priority, and perhaps do yet in quality. Fire-works are said to have been first used in Europe by the Florentines, and are mentioned as a part of the pageant at the marriage of Henry VIII. and Anne Boleyn. They were not common during the reign of Elizabeth, but came into popular use during the reigns of the Stuarts.

Marcus Græcus, in a treatise on pyrotechny (*Liber Ignium*) published about A. D. 825, describes the nature of the composition for making fire-works.

The bearing of fire-works on the invention of fire-arms is referred to in the article on GUNPOWDER (which see). See list under PYROTECHNICS.

Fir'ing. 1. (*Furnace.*) The mode of introducing fuel into the furnace and working it.

Hard-firing; charges in quick succession with frequent stoking.

Heavy-firing; large charges of fuel and frequent stoking. Known also as *close*-firing, *thick*-firing, and *charging*, from the large body of fuel introduced at a time.

Light-firing; moderate and frequent in quantity; coking the charge on the *dead-plate* and then pushing it on to the coals. Also called *open*-firing, as the charge is thinly spread on the grate-bars and the draft is free.

2. (*Glass.*) The process of fixing the colors upon glass. The colors are metallic oxides, ground up with flint glass and borax, and laid by a paint-brush upon the pieces or sheets of *crown-glass*. These are then removed to the kiln, where the colors become fused and unite inseparably with the surface of the glass on which they are laid, the flux enabling the color to melt before the glass plate becomes distorted by the heat. The *crown-glass* being a silicate of potash and lime is much more intractable than a glass into whose composition lead enters. See GLASS-COLORING; GLASS-PAINTING; GLASS-STAINING; ENAMEL.

Fir'ing-i'ron. A farrier's cautery.

Firm'er-chis'el. A chisel, usually thin in proportion to its width. It has a *tang* to enter the handle, in contradistinction to the *framing*-chisel, which has a socket into which the handle fits.

Firmer-chisels are usually eight or twelve in a set of different widths. They are shorter than *paring*-chisels and lighter than *framing*-chisels.

First-coat. (*Plastering.*) The primary coat of coarse-stuff. That of two-coat work is called *laying*, when executed on lath, and *rendering*, when on brick.

The first coat of three-coat work is called *pricking-up* on lath, *roughing-in* on brick.

Fish. 1. A strengthening or stiffening bar laid alongside another; as —

The *fish-bar*, which splices the ends of adjacent railroad rails and decreases the tremor or depression at the joint. See FISHING.

One of a pair of bars laid on opposite sides along and tightly lashed to a spar which has been sprung. See SPLICE.

2. A purchase for hauling in on to the gunwale the fluke of an anchor.

Fish-bar. The splice-bar which breaks the joint of two meeting objects, as of railroad rails or scarfed timber. See FISHING.

Fish-beam. A beam with a bulging belly.

Fish-bel'lied. Bellying on the under side, as a beam, a rail, etc.

Fish-block. (*Nautical.*) The block of the fish-tackle for raising the anchor.

Fish-da'vit. (*Shipbuilding.*) A spar or small crane projecting from the bow of a ship for the suspension of the tackle, called the *fish-fall*, used in hauling up the arms of the anchor in getting it aboard. The fish-davit is such a distance abaft the *cat-head* as the length of the anchor may require, and is used to lift the fluke of the anchor to the bill-board; a roller keeps the fluke from bruising the vessel's side.

In preparing for *letting go* the anchor, it is suspended by its throat from the *fish-davit* by a chain or rope called the *shank-painter*, which is cast loose simultaneously with the *cat-head stopper*, the two being secured *on board* by means of movable pins called *tumblers*, which are moved by a lever and disengage the chains or ropes at the same instant.

Fish'er-man's-bend. A sailor's knot, used in bending halyards to a studding-sail yard. Two turns are taken round the spar, the end passed between them and the spar, and half hitched around the standing part.

Fish-fall. (*Nautical.*) The tackle depending from the *fish-davit* and used in hauling up the *arms* of the anchor.

Fish-flake. A structure on which fish are spread to be air and sun dried.

Fish-front. (*Nautical.*) Curved pieces of timber bound upon the outside of a broken spar to stiffen it and make it serviceable.

Fish-garth. A staked or dammed enclosure on the margin of a river to form a fish-preserve.

Fish-gig. A spear with several barbed prongs used in spearing fish. It has usually five prongs, called *grains*.

Fish-globe. A spherical glass vessel forming an aquarium.

"Thence to see my Lady Pen, where my wife and I were shown a fine rarity; of fishes kept in a glass of water, that will live so for ever, and finely marked they are, being foreign." — PEPYS'S *Diary*, 1665.

Fish-glue. Isinglass.

Fish-hook. Fish-hooks are mentioned in the Bible in several places, in connection with brooks, rivers, and the sea.

The first fish-hooks were made of bones or thorns, the latter being indicated by the root of the Hebrew word.

"Canst thou draw out leviathan with a hook" (ancient version, "thorn"), "or his tongue with a cord which thou lettest down?"

"Canst thou put a hook into his nose? or bore his jaw through with a thorn?" — *Job* xli. 1, 2.

The latter verse bears a peculiar significance, referring to the practice of attaching a fish by a hook and cord to a stake, so as to keep it alive in the water. The crocodile, if it be the animal referred to, would require a hook rather larger than those used by the anglers of the Euphrates, with which river we suppose the patriarch of Uz to have been familiar.

The natives of the South Seas in the regions visited by Magellan, Cook, La Perouse, Anson, and others, made fish-hooks of bone, carved or neatly

Fig. 2000.

Fish-Hooks.

framed together and bound with sinews. Such are common in the museums, along with the bone knives and cutting instruments made of shark's teeth lashed to a back piece, the primitive saw. A mother-of-pearl hook with attached tuft of hair to act as bait is known as *witte-wittee*.

The old Egyptian fish-hooks were of bronze. See one in Dr. Abbott's collection, New York.

Homer mentions the "barbed hooks" as used by Ulysses and his companions in Sicily: —

> "All fish and birds, and all that come to hand
> With barbed hooks."
>
> *Odyssey*, XII. 322.

Athenæus states (A. D. 220) that "the hooks were not forged in Sicily, but were brought by them in their vessel." — *Athen. Epit.*, B. I. 22.

Of the Grecian fish-hooks, some were bent around and others were straight, with a barb.

In the cut are shown a number of fish-hooks, of which *a b* are two forms of a spring hook in which a mousing-piece engages the barb.

c d are two positions of the same spring hook, one set and the other sprung.

e is intended to give the hook a square presentation, and prevent glancing of the hook in striking.

f has a tripping hook which strikes from above, and supplements the primary hook.

g has a spiral-spring shank.

h has a spring hook attached to the snood, which affords the means of attaching a bait or other hook.

i has an additional hook, which is sprung, and thus supplements the primary hook.

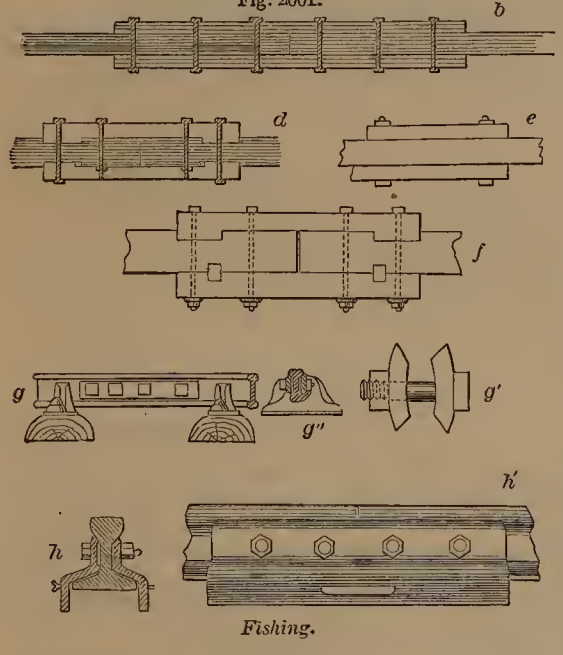
j has spiral vanes, so as to revolve it when drawn through the water in trolling.

k l shows two forms — on different scales — of a spring hook whose claws are thrown down upon the fish which tampers with the bait.

In making the hooks, straight wires of the proper size and length are flattened at one end, and the barb formed by a single blow with a chisel. The point having been sharpened, the proper curve or twist is given to the hook; the soft iron is then case-hardened, to give it the stiffness and elasticity of steel, by immersion in hot animal charcoal. The hooks are subsequently brightened by friction, and tempered. In the hook-making machine, the wire is run from a reel into the machine, and on the other side the fish-hook drops out completed, with the exception that it must be tempered and colored. After the wire reaches a certain point, the requisite length is clipped off. The next operation barbs it; the other end is flattened. It passes around on revolving dies, whose teeth, formed like the notched spikes of a wheel, catch it, and bear it from one operation to the next until it is smoothed and filed, when it passes between rollers that give it the prescribed twist and turn, and it drops into the receiver awaiting it.

Fish'ing. 1. Uniting by clamping between two

Fig. 2001.



Fishing.

short pieces which cover the joint. As a compound beam, *b d e*, Fig. 2001.

At *f* is shown a combination of *fishing-pieces*, *coaks*, and *bolts;* the coaks on the lower surface are substitutes for the *indents* of the surface above.

g g' g'' show one form of clasping plate in several views.

The *fish-plate h h'* for railway-rails has a bend which laps upon the foot of the rail, and a drooping flange; the bent form giving a rigidity which strengthens the rail against deflection. The rail is prevented from opening at the joint, or spreading, as is usual with the ordinary fish-joint, whose strength is only equal to one third that of the rail.

2. (*Nautical.*) Lifting the anchor-fluke on to and over the gunwale.

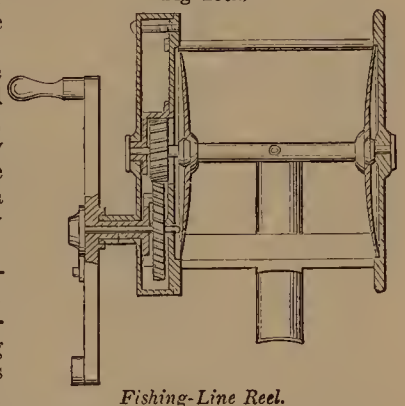
3. Fishing, as an occupation, is perhaps almost coëval with our race. The distinction between netting, trapping, and angling was early understood. "The fishers also shall mourn, and all they that *cast angle* into the *brooks* shall lament, and they that *spread nets upon the waters* shall languish. . . . . They shall be broken. . . . that make *sluices* and *ponds* for fish." (Is. xix. 8, 10.) See also Habakkuk i. 14, 15; Amos iv. 2 (787 B. C.). Oppian wrote a Greek epic on fishes and fishing about A. D. 198. Wynkyn de Worde's "Treatyse of Fysshinge" appeared in 1496, and Walton's "Complete Angler" in 1653.

Fish'ing-line. A flaxen or fine hempen cord for angling.

The Grecian fishing-lines were of horsehair, white nearest to the hook. Horsehair, catgut, and silk are now used for *snoods*.

Fish'ing-line Reel. A little winch, usually attached to a fishing-rod, and upon which the line is wound.

Fig. 2002.



Fishing-Line Reel.

In one case it is furnished with an alarm, so that a sleepy fisher may have notice when a fish runs away with the bait.

Fish'ing-net. See NET.

Fish'ing-rod. Angling for fish was common in ancient Egypt, but they do not appear to have used a float. The line was comparatively short, and the rod in a single length. They used landing-nets. They do not seem to have practiced fly-fishing. Spearing fish, especially with the *bident*, is shown frequently in their sepulchral paintings. The fish-spear was attached to a cord which was wound on a reel.

The hook and fish-spear are mentioned in the Book of Job. Fishing-lines of horsehair are mentioned by Aristotle.

The Grecian fishing-rod was, as now, a reed, — *calamus*. It was not made in jointed sections.

Modern rods are made of bamboo lengths fastened together by telescopic or screw couplings.

Fish'ing-smack. A sloop having a water-chamber in the hold to keep fish alive.

Fish'ing-tube. (*Microscopy.*) An open-ended glass tube for selecting a microscopic object in a fluid. The tube is closed at the upper end by the finger until the lower end is close to the object. The finger being raised the water rushes in, carrying the object with it.

Fish-joint. A plate or pair of plates fastened upon the junction of a couple of meeting portions of a beam or plate. See FISHING.

The fish-joint for connecting railway-rails was first designed by W. B. Adams, England, 1847, and was soon extensively introduced. It consisted of a pair of plates 18 inches long, 3 by $\frac{3}{4}$ inches, bolted together through the rails by 4 bolts, allowance being

made by oval bolt-holes for expansion and contraction of the rails.

The fish-joint with keys instead of bolts was first used (Holley) by Barr of Newcastle, Delaware, in 1843.

In Samuel's fish-joint the bolt passes through a hole in one fish-plate and is tapped into the other. This obviates the nut, which is apt to be in the way of the wheel-flange.

Fish-ket'tle. A long kettle adapted to boil fish of, say, from four to ten pounds' weight, without destroying the symmetry of the fish or cutting it into pieces.

Fish-lad'der. A dam with a series of steps to enable fish to ascend the fall by a succession of leaps. See FISH-WAY.

Fish-plate. A plate used to secure together the ends of adjacent rails, to hold them strictly in line, avoiding lateral deflection or sagging. It usually consists of a plate on each side of the joint, clasping the *web* of the rail, and secured by bolts and nuts. See FISHING.

Fish-pot. An open-mouthed wicker basket containing bait, and sunk in the haunts of fish to catch them.

Fish-skin. The rough skin of the dogfish or shark is used as a rasp.

Shagreen is a leather of fish-skin.

The skins of the porpoise, beluga, and seal are tanned.

Eel-skins are used as *whang*.

Sole and other skins are used in making a kind of isinglass for clarifying liquors.

Fish-slice. A broad-bladed silver knife used for serving fish at table. The trowel-shaped blade enables a portion of fish to be removed from the backbone without breaking it into unsightly fragments.

Fish-spear. A barbed spear for catching fish. A *gig*.

Fish-spears are mentioned by Job and by the Greek writers. They had one, two, or more barbed prongs. Neptune's trident was a fish-spear, tridented or three-toothed.

Fish-tack'le. (*Nautical.*) A purchase to raise the flukes of an anchor to the gunwale, for stowage, after being *catted*. A *fish-fall*.

Fish-tail Burn'er. A gas-burner whose burning jet assumes a two-lobed form, like the tail of a fish.

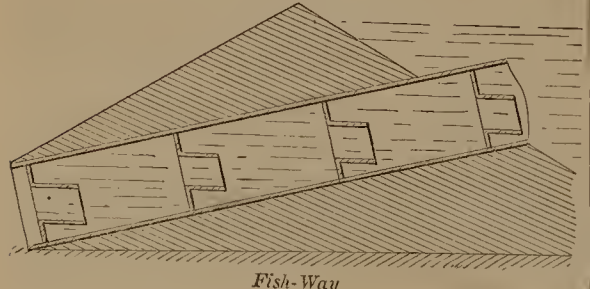
Fish-tail Pro-pel'ler. A single-winged propeller hinged to the stern-post and oscillating like the tail of a fish.

Fish-trap. A box or basket set in a river and having bait slung in a bag to attract fish; it is sprung by hand.

A basket, net, or staked area with a divergent-sided or funnel-shaped opening through which fish pass, and in which they find a difficulty in retracing their course, owing to obstacles or blind sacs.

Fish-way. A device to enable a fish to ascend a fall. It may consist of a series of steps over which the water descends, turning a fall into a cascade, and sometimes known as a fish-ladder; or it may consist of a chute with a sinuous track for diminishing the velocity and assisting the passage of the fish to the level above the dam. In the example, it is an inclined chute having a series of chambers containing comparatively still water, the current being confined to a relatively smaller space.

Fig. 2003.



Fish-Way

Fis'sure-nee'dle. A spiral needle for catching together the gaping lips of wounds. By revolution, the point is made to pierce the lips alternately, carrying its thread with it. Tiemann's needle for cleft palate is hollow throughout its length, and carries a silver wire which is left in its place when the needle is retracted by backward rotation.

Fig 2004.

Fissure-Needle.

Fis'tu-ca. A pile-driver. A *monkey*.

Fis'tu-la. A water-pipe, according to Vitruvius, who distinguishes three modes of conveying water: by leaden pipes, by earthen pipes, and by channels of masonry.

Fit-rod. (*Shipwrighting.*) A gage-rod used to try the depth of a bolt-hole in order to determine the length of the bolt required.

Fix. See FIXING.

Fixed Am'mu-ni'tion. A charge of powder and shot inclosed together in a wrapper or case, ready for loading.

Fixed Light. One character of light displayed from a lighthouse. Its beams are constant, differing from those termed *flashing*, *revolving*, and *intermittent*. It is susceptible of variation, as *white* or *colored*, *single* or *double*. See LIGHT; CATOPTRIC-LIGHT.

Fixed Star. (*Pyrotechnics.*) A composition introduced into a rocket-case and emitting fire at five holes, to represent a star. The composition is niter, sulphur, gunpowder-meal, antimony.

Fixed Sun. (*Pyrotechnics.*) A device composed of a certain number of jets of fire distributed circularly like the spokes of a wheel. All the fuses take fire at once through channels charged with quick-matches.

Glories are large suns with several rows of fusees.

Fans are portions of a sun, being sectors of a circle.

The *patte d'oie* is a fan with only three jets.

Fix'ing. 1. (*Photography.*) Of a *negative;* the removal, by a solution of hyposulphite of soda or cyanide of potassium, of the unaffected deposit of iodide and bromide of silver in the collodion film after exposure and development of the picture.

Of a *positive;* the removal of the unaltered chloride of silver from the surface of the photographic paper after exposure under the negative.

2. (*Metallurgy.*) The material used in preparing the hearth of a *puddling* or *boiling furnace* for receiving its charge. A certain amount of ore, cinder, and scrap are banked up around the boshes, the amount and kind varying with the character of the iron and the construction of the furnace. It is called *fettling* in some parts of England, the word *fettle* being provincial English, and substantially the same as our *fix*.

Flack'et. A barrel-shaped bottle.

Flag. 1. A banner indicating nationality, occupation, or intelligence.

Flags of *nationality* are *standards*, *ensigns*, *pennants* (pendants), *jacks*.

Flags of *occupation* indicate service, as *war*, *merchant*, *despatch*, *pilot*, *yacht-squadron*, *liners*, etc.

Flags of intelligence are of various colors and of three shapes: square (*a*), pointed (*b*), burgee (*c*). They are used in various combinations to transmit messages according to a printed or secret code.

The *standard* (*military* or *naval*) is a *war* flag.

The *ensign* (*d*, American ; *e*, English) is national. It has the *union* in the upper corner next the staff, the other portion of the flag being denominated the *fly*.

In the English service the ensign with a white fly, a red cross, and the jack in the corner, belongs to war-vessels. Other government vessels carry the *red* ensign (red fly).

The *blue* ensign belongs to the merchant service.

The *pennant* (*f*) is a long strip of bunting, and is used to indicate the commodore's vessel, and formerly, in connection with an ensign, to indicate a government vessel of the nationality to which the ensign belongs.

The *jack* is a flag having the *union* of the ensign without the fly. *g*, American ; *h*, English.

An *anvil* is a little narrow flag or pennon on the end of a lance.

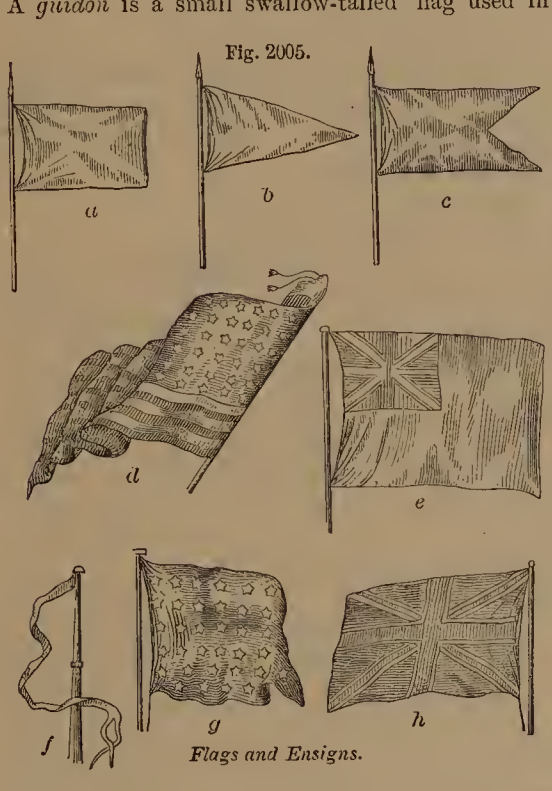
A *banner* is a small flag edged with fringe.

A *bandrol* is a small streamer from a masthead.

A *fanion* is a small flag for a surveying-station ; from the Italian *gonfalone*, a standard.

A *guidon* is a small swallow-tailed flag used in

Fig. 2005.



Flags and Ensigns.

cavalry regiments. One is furnished to each company. See GUIDON.

A *streamer* is a relatively narrow flag or pennon.

Flags with special designs are used on particular occasions, as the flag known as "blue-peter" indicates that the vessel is about to sail. It is a blue flag with a white square in the middle. There are many other signal flags, and some to represent numbers, by which messages may be signaled according to a printed code. See Haswell's "Engineers, etc., Pocket Book," p. 149.

The *hight* of an ensign is the *hoist* or *depth*, and is $\frac{1}{3}$ of its length.

The *length* from the staff to the outer edge is the *fly*.

In the United States service, —

The garrison flag has 20 feet head, 36 feet fly.

The storm-flag has 10 feet head, 20 feet fly.

The regimental flag has 6 feet head, 6 ft. 6 in. fly.

Camp-colors are of bunting, 18 inches square.

The *field* has 13 horizontal stripes of red and white alternately, beginning with red.

The *union* has a blue field in the upper corner, next the *head*, four tenths of the length of the field and seven stripes in depth, with white stars ranged in equidistant horizontal and vertical lines, equal in number to the number of States in the Union. See "Army Regulations," ed. 1863, p. 461.

2. A slab of stratified stone for sidewalks, etc.

3. The uneven end of an uncut tuft of hair in a brush.

Flag'e-o-let. (*Music.*) A wooden musical wind-instrument having a mouthpiece and six principal holes which are stopped by the fingers, as in a flute.

The double flageolet is said to have been invented by Bainbridge, and upon it duets may be played. It is mentioned by Pepys.

"To Drumbleby's, the pipe-maker, there to advise about the making of a flageolet to go low and soft ; and he shew me a way which do do, and also a fashion of having two pipes of the same note fastened together, so as I can play on one, and then echo it on the other, which is mighty pretty." — PEPYS's *Diary*, 1668.

"I took my flageolette, and played upon the leads in the garden, where Sir W. Pen come out in his shirt into his leads, and there we staid talking and singing and drinking greater draughts of claret, and eating botargo and bread and butter, till 12 at night, it being moonshine, and so to bed, being very near fuddled." — PEPYS's *Diary*, 1661. (Botargo is a sausage made of eggs and the blood of the sea-mullet.)

Flag'ging-i'ron. (*Coopering.*) A prying-rod with a double-hooked head, used in flagging casks.

Flag'on. A pitcher with a narrow mouth to hold a beverage, ale or wine.

Notably it is of metal, and used to contain the wine of the communion-service, which is poured from thence into the chalice and drunk therefrom.

Flag-stone. A sandstone which cleaves into flat slabs suitable for paving.

Flail. 1. (*Husbandry.*) A wooden instrument for threshing small grain by hand.

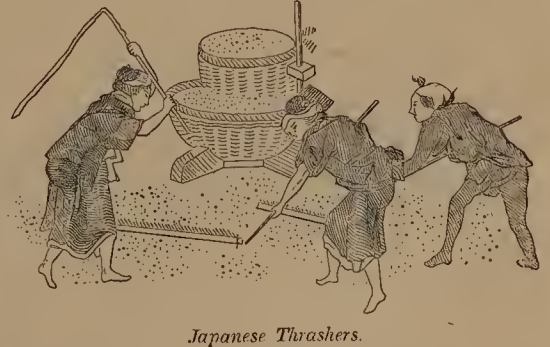
"The fitches are beaten with a staff, and the cummin with a rod." — *Isaiah.*

It was used among the Hebrews for grain which would not bear the tramping or the grinding action of the sled or cart.

The flail consists of the *hand-staff* and the *souple*, or *swiple*, which are joined by a piece of whang or eelskin to a swivel called the *hooding*.

The images of the Egyptian Osiris are represented

Fig. 2006.



Japanese Thrashers.

with two instruments, usually called the *crook* and *flagellum*. We are much disposed, however, to consider them a *sickle* and *flail*, and the association on the same figure of the plow and harrow renders the

supposition probable. The crook was not held in as much honor as the sickle, nor the tender of animals as the cultivator of the land. A weapon like a flail was used in war, but Osiris was eminently peaceful and useful, and his emblems had the same character.

The flail is the ordinary means of thrashing in Japan. It differs in no essential respect from that of other countries. The illustration, from a native painting, shows that both sexes engage in the work.

2. An ancient weapon used in war. It was a club swinging from the end of a long handle, like the *morning-stars* of the London train-bands, three centuries since.

A war-club studded with *iron* spikes and mounted like a flail was found at Sakkarah, and is in the Abbott Museum of Egyptian Antiquities in New York.

Flake. 1. A platform of slats, wands, or hurdles, on which fish or fruit is placed to dry. A *fish-flake.*

2. A stage suspended over the side of a ship for the convenience of the painters or calkers.

Flame-bridge. A wall rising from the floor of a furnace to cause the flame to impinge upon the bottom of the boiler.

Flame-en'gine. An early name for the gas-engine, in which the piston is moved by the expansion due to the sudden combustion of a body of gas in the cylinder. See GAS-ENGINE.

Flang. A two-pointed miner's pick.

Flange. (*Machinery.*) A projecting rib or rim for strength, as a guide, or for attachment to another object.

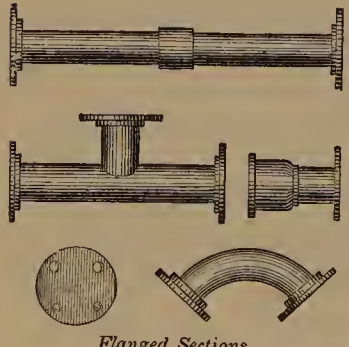
1. A strengthening rib, as in the flange of a fish-bellied rail, or girder.

2. A guide-flange, as in the rib of a car-wheel projecting beyond the tread.

3. A fastening flange, as on the end of pipe, steam-cylinder, etc.

Flange-joint. A joint — such as that of pipes — where the connecting pieces have perforated flanges by which the parts are bolted together.

Fig. 2007.



Flanged Sections.

Flange-rail. A rail having a bent-up flange to keep the wheel on the track.

Flang'ing-ma-chine'. (*Sheet-metal.*) A machine usually having two rollers so constructed and arranged as to bend over the edge of a piece of tin-plate which is passed between them. The modes of bending are known as *bending, burring, seaming, flanging,* etc.

In the example, the outer circumferential corner of the lower disk is turned out rectangularly, and the other disk has a peripheral flange, which enters the groove and forms an out-turned flange around the edge of the cylinder. See DOUBLE-SEAMING MACHINE.

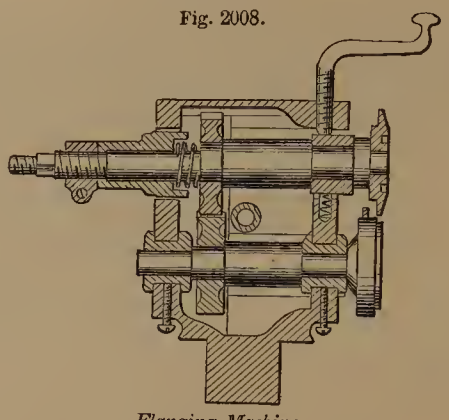
Flank. 1. (*Gearing.*) The acting surface of a cog, *within* the pitch-line. The outer portion is the *face.*

2. (*Architecture.*) The *haunch* of an arch; the shoulder between the *crown* and the *springing.*

3. The thin portion of a skin of leather; that which previously covered the flank of the animal.

4. (*Fortification.*) That portion of a bastion which reaches from the *face* to the *curtain.* The *flank* of one *bastion* commands the *ditch* before the *curtain* and the *face* of the opposite *bastion.* See BASTION.

Fig. 2008.



Flanging-Machine.

5. The return side of any body, as of a house, a wall, an ashlar in position, etc.

Flan'nel. (*Fabric.*) A soft, open woolen stuff, of which there are many kinds, twilled or plain and undressed, milled, gauze, colored, and checked. Also made for specific purposes, as house, horse, printer's blankets.

Flan'ning. (*Building.*) The internal flare of a window jamb. The *embrasure.*

Or of a fireplace. *Coving.*

Flap. A hinged leaf of a table or shutter.

An inside shutter has several pieces, the principal one of which is the *front shutter;* the one which folds into and is concealed in the *boxing* is the *back-flap.*

Flap-tile. A tile with a bent-up portion to turn a corner or catch a drip.

Flap-valve. A valve which opens and shuts upon one hinged side. A *clack-valve.*

The common pump-valve consists of a disk of leather opening upward when the pump-rod descends, and has a leaden or brass weight attached to it.

Flar'ing. Overhanging, as of the bows of a ship, the top side forward.

Increasing in diameter upward, as of an upwardly expanding pan. *Funnel-shaped, conical, trumpet-mouthed.*

Flash'er. (*Steam.*) A form of steam-boiler in which small bodies of water are injected into a heated boiler and flashed into steam, sufficient being injected at each time for one stroke. See INSTANTANEOUS-GENERATOR.

Flash'ing. 1. (*Hydraulic Engineering.*) Concentrating a fall of water at one point, so as to increase the depth to allow the passage of a boat from one level to another, as at *a.* The river having a *dam* across it and a sluice at one point, the sluice-gate is opened, and during the temporary increase of depth in the sluice-way the boat is drawn through.

It is a very ancient device (see SLUICE), and is still used in many countries with boats of moderate size.

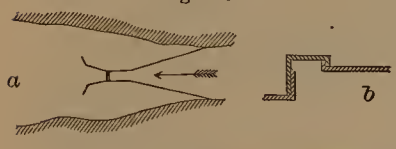
A memorable case of flashing is that when Lieutenant-Colonel Bailey rescued the fleet of gunboats on Red River after the defeat of the Union army under General Banks. The gunboats were *flashed* over the falls at Alexandria by means of a wing-dam made of log cribs filled in with stone.

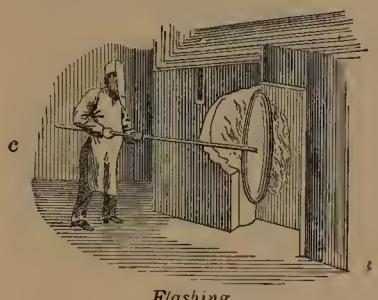
2. (*Plumbing.*) *a.* A lap-joint (*b*) used in sheet-metal roofing, where the edges of the sheets meet on a projecting ridge.

b. A strip of lead leading the drip of a wall into a gutter.

Step-flashings are those situated at the junction of the sloping side of a roof and a wall. They are turned in at each course of bricks and stepped down as the roof descends.

Fig. 2009.





Flashing.

3. (*Glass-making.*) *a.* A reheating at a furnace aperture (*c*) in connection with a rotary movement, causing the opening in the flatted sphere of glass to enlarge and eventually to disappear entirely as the table of glass assumes a flat shape.

The flashing heat is also applied to smooth the sheared edges of a goblet or other article, or to reheat an article during manufacture to restore its plastic condition.

b. A mode of covering transparent white glass with a film of colored glass, in order to give the appearance of color to the whole ware. In some cases, the ruby coating is ground away in an ornamental pattern, so that the glass is party-colored. The colored glass is prepared with a composition called SCHMELZE (which see).

Flash'ing-fur'nace. One at which a globe of crown-glass is reheated, to allow it to spring open flatly as it is whirled. See FLASHING.

Flash'ing-light. One character of light as exhibited from lighthouses. It is produced by the revolution of a frame with eight sides, having reflectors arranged with their faces in one vertical plane and their axes on a line inclined to the perpendicular. The rate of revolution is such as to show a flash of light every five seconds, alternating with periods of dimness.

This light is one of the modes of varying the appearance, so that a mariner may be able to distinguish one light from another when coming near land on a coast where the number of lights is considerable; as, for instance, the three kinds on Cape Henry and Cape Charles, at the mouth of Chesapeake Bay, and at Hog Island, on the coast of Northampton County, Virginia, about thirty miles north of Cape Charles.

Lights are distinguished as —

Fixed.	Flashing.
Revolving.	Colored.
Intermittent.	Double.

These are variously combined, as: *revolving white; revolving red and white; revolving red and two whites; double fixed; double revolving*, etc., etc. See LIGHT; LIGHTHOUSE. See "Lighthouses, their Construction and Illumination," by Allan Stevenson; Weale's Series, No. 47.

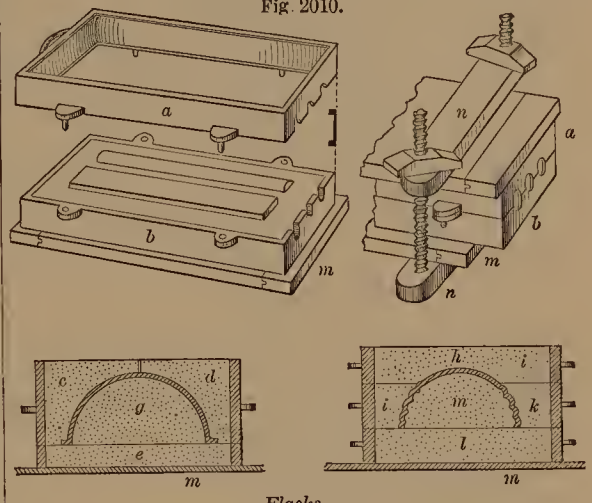
Flash-pipe. A mode of lighting gas by means of a supplementary pipe pierced with numerous small holes throughout its length. The *flash*-pipe reaches from the burner to a position within reach of a person, and is provided with a stop-cock. The cock being turned, gas issues from each orifice. One jet being lit, the flame flashes along the whole length of the pipe, and communicates flame to the jet. The stop-cock is then closed, and the row of small jets is extinguished. Substitutes for the *flash-pipe* are found in the various modes of *lighting gas by electricity* (which see).

Flash-wheel. A water-raising wheel having arms radial or nearly so to its axle, and revolving in a *chase* or curved water-way by which the water passes from the lower to the higher level as the wheel rotates. See SCOOP-WHEEL. See also HYDRAULIC DEVICES.

Flask. 1. (*Founding.*) A frame or box which holds a portion of the mold for casting. If the mold be contained in two pieces, they constitute a *two-part* flask. The upper part contains the *eope* (*a*), the lower part the *drag* (*b*).

In hollow-ware, kettles, etc., the cope consists of two parts *e d*, which divide laterally, and the drag *e* has one part and holds the *core*, or *nowel g*, which is the mold of the interior. This requires a three-part flask.

Fig. 2010.

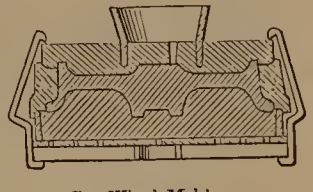


Flasks.

An example of a four-part flask is one in which the *eope* or casing is in three pieces; one upper piece *h* which is lifted off, and two side pieces *i k* which are removable laterally. The *core* or *nowel m* resting upon the fourth part *l*, the drag. The *drag l* rests upon a bottom board *m*, and has ears at the sides into which the pins of the cope enter, so as to preserve the parts in relative lateral position. When the object is molded and the pattern withdrawn, the *parts* of the flask are secured between top and bottom boards by means of the clamps *n*. See MOLD.

Fig. 2011 shows a car-wheel in a mold with its upper and lower parts and a circular ring which forms and at the same time chills the tread.

Fig 2011.



Car-Wheel Mold.

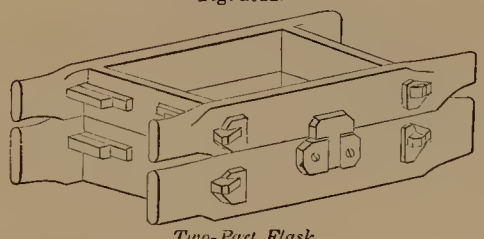
Fig. 2012 shows a two-part flask with the mode of securing exact correspondence of the parts by locking hooks and keepers.

2. A leathern or metallic case for holding gunpowder or shot.

3. (*Glass.*) *a.* A kind of bottle for oil, liquor, or quicksilver. The latter is of iron.

b. A vessel used in a laboratory for sublimation or for digesting in a sand-bath.

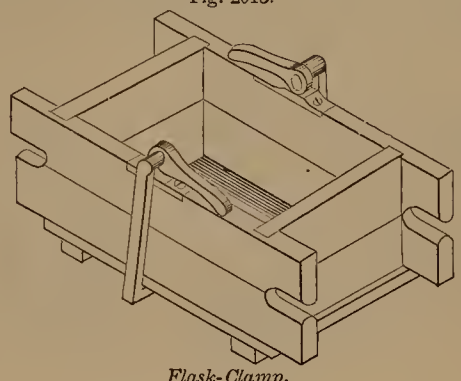
Fig. 2012.



Two-Part Flask.

Flask-clamp. A binding device for securely holding together the parts of a flask. In the example it is a hooked bar and a lever cam.

Fig. 2013.



Flask-Clamp.

Flask'et. A long shallow basket with two handles.

Flat. 1. A Western river-boat or barge for carrying produce, coal, or merchandise.

2. A piece of bone for a button-blank.

3. A surface of size over gilding.

4. A story in a dwelling.

5. A platform railway car.

6. (*Carding.*) A strip of wood clothed with bent teeth, and placed above the large cylinder of a carding-machine.

The clothing is known as the *flat top-cards*, in contradistinction to the cards which clothe the *drum*, *licker-in*, *card-rollers*, *teazer*, and *doffer*, whose surfaces are curved.

7. (*Shipbuilding.*) *a.* A flat part in a curve; as a timber which has no curve, as the floor-timbers of the *dead-flat* amidships.

b. One of a number of ship's frames of equal size, and forming a straight middle body.

Flat'band. A plain, square impost.

Flat-boat. A barge for transporting produce on the Western rivers. A *flat*; an *ark*.

Flat-cap. A size of writing-paper usually 14 × 17 inches.

Flat Chis'el. A sculptor's chisel for smoothing surfaces.

Flat File. A file wider than its thickness and of rectangular section. When bellied, it is known as a *taper* file; when the size is maintained from end to end, it is known as a *parallel* file.

Flat Ham'mer. The hammer first used by the gold-beater in swaging out a pile of *quartiers*, or pieces of gold ribbon, 1 × 1½ inches square. These are placed 24 in a pile and beaten till they are two inches square. They are then packaged with interleaves of vellum and beaten by other hammers, known as the *commencing*, *spreading*, and *finishing* hammers.

Flat-head Nail. A forged nail with a round, flat head and a light, rounded, pointed body.

Flat-i'ron. An iron with a flat face, used for smoothing clothes. A *sad*-iron. See SMOOTHING-IRON.

Flat-i'ron Heat'er. A stove specially adapted for heating smoothing-irons. A *laundry-stove*.

Flat-lead. Sheet-lead.

Flat-nail. A small, sharp-pointed wrought nail, with a flat, thin head, larger than a *tack*.

Flat-pa'per. That which has not been folded.

Flat-press. A press used in the india-rubber business for flattening together a number of piles of folded cloth while they are vulcanized and blended together by a steam heat of say 280° F.

Flat-rail. A railroad rail consisting of a simple flat bar, spiked to a longitudinal sleeper. Tramways of wood were laid down by Beaumont at Newcastle, in 1602. They were protected by flat straps of iron in 1738, at Whitehaven. Flat cast-iron plates were laid at Coalbrookdale in 1767. The angular cast-iron rail was used in 1776. Edge rails of cast-iron in 1789. Rolled rails in 1820. See RAIL.

Flat-rope. A rope made by plaiting yarns together instead of twisting. *Gasket; sennit.*

Some flat ropes, for mining-shafts, are made by sewing together a number of ropes, making a wide, flat band.

Flat-rope Pul'ley. A pulley having a true cylindrical surface and two rising flanges, to keep the band from running off. See PULLEY.

Flat'ten-ing-fur'nace. A furnace into which cylinder glass split longitudinally is placed to flatten out by heat. A *spreading-oven*. See FLATTING-FURNACE.

Flat'ter. 1. A hammer with a very broad face, used by smiths in flat-facing work.

2. (*Wire-drawing.*) A draw-plate with a flat orifice, to draw flat strips, such as watch-springs, skirt-wire, etc.

Flat'ting. 1. (*Painting.*) *a.* A style of inside house-painting in which the colors, prepared with oil of turpentine only, are dead, without luster.

b. A covering of size over gilding.

2. A rolling of metal into plates.

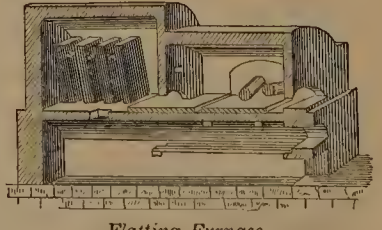
3. (*Glass-making.*) The operation of opening out a split cylinder of glass so as to make it flat. This is performed in a FLATTING-FURNACE (which see), and is assisted by a tool having an iron handle and a wooden cross-piece at the end.

The plate on which it is flatted is of devitrified glass, fire-proof clay, sandstone, or other material which will resist heat and maintain the essential perfectly smooth surface.

It is known as the *spreading-plate*, *flatting-plate*, *flatting-stone*, or *flatting-hearth*.

Flat'ting-fur'nace. One in which a split cylinder of glass is opened out. See FLATTING.

Fig 2014.



Flatting-Furnace.

William Coffan, of Hammonton, New Jersey, patented a machine for flattening cylinder glass, October 1, 1830, which was intended to prevent injury to the glass while cooling by shifting the stone on which it was flattened from the flattening to the cooling oven.

Flat'ting-mill. 1. A rolling-mill producing sheet-metal.

In the Mint; the rolling-mill for producing the ribbon from which the planchets are punched.

The first flatting-mill in England was erected at Sheen, near Richmond, by a Dutchman, 1663.

2. A mill having a pair of hard, polished steel rolls, through which grains of metal are passed to be flatted, for ornamental purposes. The produce is known as *metallic dust.*

Flat-tool. A turning-chisel which cuts on both sides and on the end, which is square. It is used as a bottoming-tool for boxes.

Flaw. 1. (*Weaving.*) A *bore*, *tangle*, or *skip.*

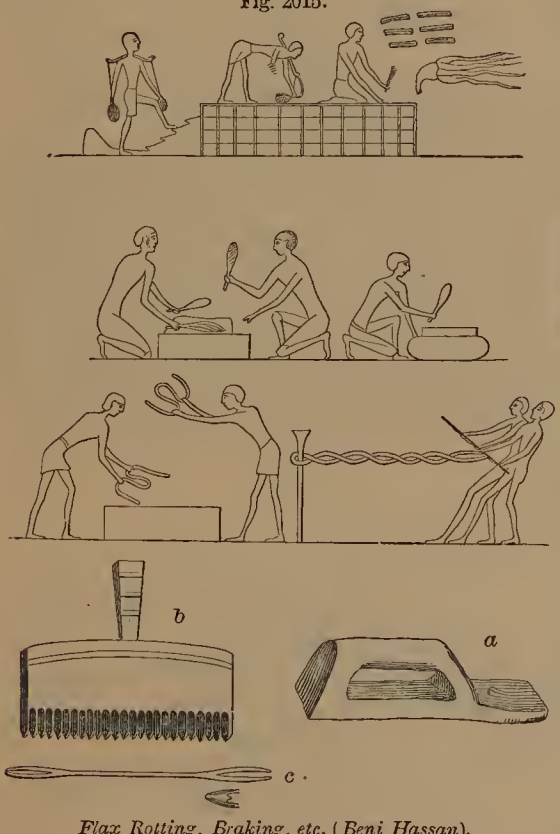
2. (*Metal.*) In casting or forging; a fault, as where the parts of the metal are not fairly joined.

Flaw-piece. (*Wood.*) A slab, from the outside of the log.

Flax. The first mention of flax in history is perhaps that in the account of the hail-storm in Lower Egypt, Exodus ix. 31: "The flax was bolled." The Hebrew word is rendered *linon* in the Septuagint; *linum* in the Vulgate: with us it is *line* and *linen.* (See LINEN.) Flax was used to the exclusion of wool for priestly garments and cerements. Isaiah refers to the fine linen of Egypt; Herodotus refers to linen shirts as the ordinary dress of the people of the Nile land.

The manipulations of flax to render it fit for use are shown at Beni Hassan in Egypt, about 1500

Fig. 2015.



Flax Rotting, Braking, etc. (*Beni Hassan*).

B. C. In the illustration the men on the left are carrying water in jars to pour on the flax, which is placed in an elevated cistern, partitioned off into cells. Another man removes the rotted flax and lays it out to dry, as represented by the six bunches. Another bunch is shown in a loose condition, probably a handful in condition for the next operation, which is performed by the three kneeling men, who beat upon a stone with a mallet *a.* The flax is thus made into a rough hank, and is then cleaned and opened out more fully by striking it upon a stone. The hank is held in two places, swung in the air, and beaten upon the flat stone. In the next scene the hank is twisted and worked to give it a farther finish.

The description given of the process by Pliny, who wrote about 1500 years afterwards, will nearly apply to the serial picture just described. He says: "The stalks themselves are immersed in water, warmed by the heat of the sun, and are kept down by weights placed upon them; for nothing is lighter than flax. The membrane or rind becoming loose is a sign of their being sufficiently macerated. They are then taken out and repeatedly turned over in the sun until perfectly dried; and afterwards beaten by mallets on stone slabs. That which is nearest to the rind is called *stupa* (tow), inferior to the inner fibers and fit only for the wicks of lamps. It is combed out with iron hooks until all the rind is removed. When made into yarn it is polished by striking it frequently on a hard stone, moistened with water; and when woven into cloth it is again beaten with clubs, being always improved in proportion as it is beaten."

Answering to the "iron hooks" described by Pliny, and to our *hackle*, were the combs like that shown in the cut *b*; two of which were found at Thebes, with some flax-tow attached, and are now in the Berlin Museum. One of them has 29 and the other one 46 teeth. *c* is a netting-needle from the same place.

Flax was exported from Egypt to Gaul as late as the Christian era, and was ordered to be grown in England by statute of Henry VIII., 1533. A braking and scutching machine was run by water-power in Scotland in 1750.

To prepare flax for manufacture, after the removal of the seeds, the *hare* (useful, fibrous portion) is separated from the *boon* (the refuse portions of the stalk). For this purpose the uniting gluten must be dissolved and removed. This is effected by rotting, either in ponds or by exposure to dew. In either case a fermentation ensues which renders the gluten soluble in water. Caustic alkali has the same effect on gluten, and forms the basis of many modern processes whereby woody fiber is rendered suitable for spinning or for paper pulp. The next process is to *break* and *scutch* the flax to detach and remove the rind and cellulose matter, and prepare the fiber for *hackling* and subsequent operations.

In one large establishment in Leeds, England, the series of machines is as follows: —

The seed is removed by rollers which act upon the bolls. Then come the *flax-braking machines;* these have fluted or grooved rollers, between which the flax stem is made to pass, so that the woody portion becomes thoroughly broken without cutting the fiber. Next come the *flax-scutching* machines, in which revolving blades or arms beat out the woody fragments, and the fibers are to a certain degree separated. After this the *flax-hackling* machines give the flax a thorough combing, by means of long rows of teeth or spikes; the fibers are combed out straight and tolerably clean; and the tow or short fibers are removed, to be used for other purposes. The hackled flax is then in a state to be acted on by the various machines which bring it into the state of yarn for weaving; these machines are of three kinds, according as tow, long flax, or cut flax is to be acted upon. The *tow-carding* and the *tow-roving* machines serve for the first kind; the *flax-spreading*, *flax-carding*, and *flax-roving* machines for the second; and the flax-cutting machine, followed by those for carding and roving, for the third. The

spinning-machine follows all these; and it differs from cotton-spinning machines chiefly in having a provision for wetting the flax either with cold or hot water; there is still a little gum or mucilage among the fibers, and this becomes more manageable in the machine when moistened.

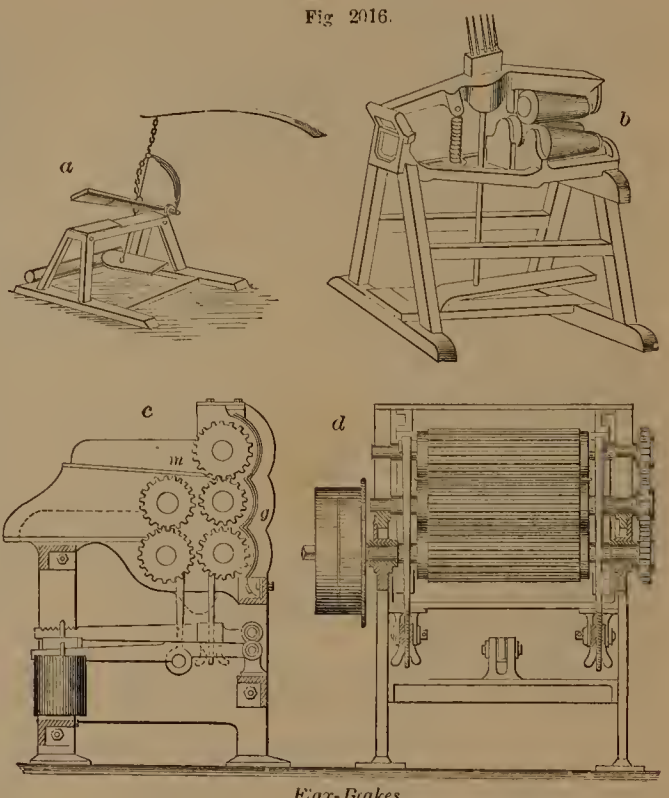
A Swedish method of treating flax is by boiling in sea-water with the addition of birch-ashes and quicklime. It is then rinsed in sea-water; soaped, rubbed, bleached in the air, being turned and watered every day. The washing, soaping, and bleaching are repeated. The flax is beaten, dried, and then carded and spun like cotton.

For list of appliances in the treatment and manufacture of flax, see COTTON, FLAX, WOOL, ETC., APPLIANCES.

Flax-brake. 1. A machine for removing the woody and cellular portion of flax from the fibrous. The hemp-brake is substantially similar in its construction and identical in its purpose.

The first mode adopted may be assumed to have been beating the rotted flax with a stick on a flat stone, alternating with rubbing by the hands. A sword of wood which descends upon the stalks laid over a pair of slats set edgeways, a farther improvement, which is shown at *a*, in which the sword is drawn down by a treadle and lifted by a spring-pole. To this succeeds a pivoted jaw with a series of parallel longitudinal serrations descending upon a similarly provided jaw on the bench.

Fig. 2016.



Flax-Brakes.

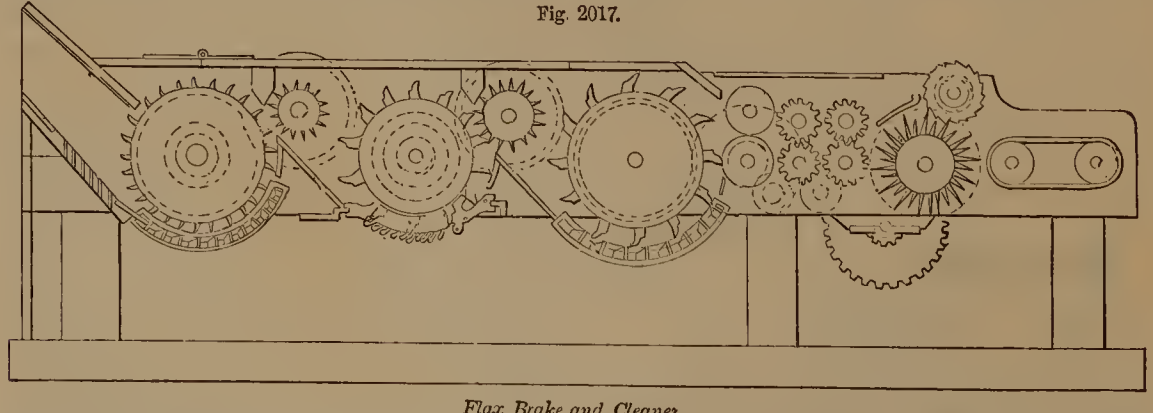
b is a machine having a system of three rollers, the upper one of which is attached to a lever which draws it down upon the other two by means of a treadle, clamping the flax, which is then drawn through by hand, breaking the *shives* from the *hare*. This is repeated as often as may be neccessary, raising the head each time for the insertion of the flax. This part of the process being completed, the flax is reduced to a fine straight fiber by means of the hackle above the lever.

The machine shown in side and end elevations *c d* has cast-iron fluted rollers, five in number, arranged in two vertical series, the front one of two rollers and the back one of three.

The flax straw fed into the machine at *m* passes between the top and middle rollers of the back series, and is directed downward by the back plate *g*, so as to pass between the middle and bottom rollers of the same series and then through the two rollers of the front series. The rollers are all driven and their ends have plain parts truly turned so that the flutes of one roller work into the spaces of the next adjoining roller, and leave a space for the flax straw to pass through. The rollers are weighted, and the pressure can be regulated as required.

Fig. 2017 shows a machine for consecutive rotary

Fig. 2017.



Flax Brake and Cleaner.

treatment. The devices are for drawing, straightening, and extending a layer of tangled flax so as to reduce it to a thin, even sheet of parallel stalks ready for the breaker, scutcher, beater, and picker, to which it is passed directly and continuously.

The drawing-cylinder has alternately long and short teeth, and the roller above has indentations in the peripheries of its annular rings for impaling the stalks. The scutching and cleaning cylinders have flat, narrow, deep teeth, with inclined front edges, slightly hooked at the ends. The teeth of the picking-cylinder are made of pointed round wire, and are inclined backward at their bases, their points curving forward. The concave of the cleaning-cylinder is formed of parallel curved grate-bars, between which pass the teeth of the cylinder. The fiber is

forwarded between each cylinder by chute and toothed shell roller.

2. A machine for shortening flax staple to adapt it to be worked by a given class of machines.

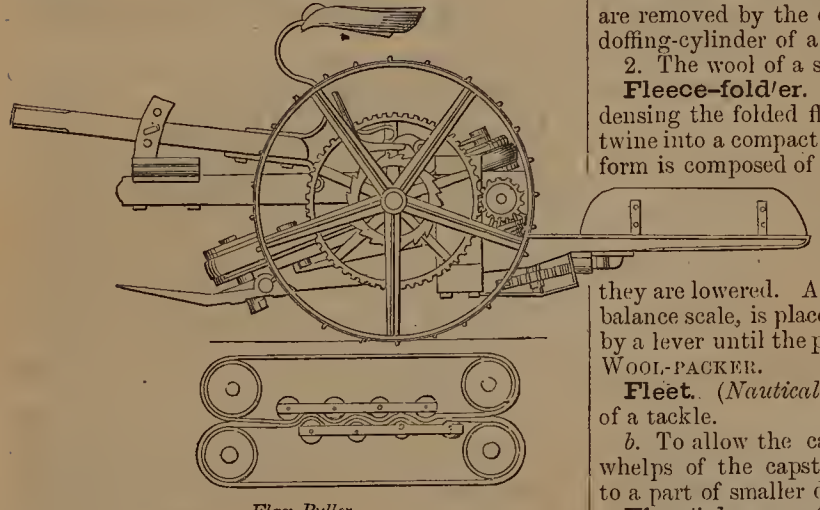
Flax-cot'ton. A process was invented by Chevalier Claussen for cottonizing flax, to render it suitable for manufacture, the objects being to expedite the processes of separating the fiber from the cellular and glutinous matters, and then reducing the fiber to a staple which can be readily treated by machinery. The flax-straw is boiled for four hours in a solution of caustic alkali in a stone vessel, by which the extraneous matters are loosened; it is then placed for two hours in a bath slightly acidulated with sulphuric acid. It is then dried and scutched to remove the cellulose. The cottonizing is performed by steeping the fiber in a bath of dilute bicarbonate of soda, and subsequently in an acidulated liquid. The action of the acid and alkali within the flax fiber generates carbonic-acid gas, and has the effect of bursting apart the fibers, which assume a cottony appearance. It is then bleached and spun, either mixed or otherwise.

In the first volume of the "Transactions of the Society of Arts" is a paper detailing the experience of Lady Moira, about 1770, in attempting to introduce flax cotton. She states that tow and refuse flax of all kinds, boiled with an alkaline solution, and afterwards soured, is converted into a sort of cotton which takes dye better than flax. Her comments are really noteworthy, and illustrate the oft-told tale of the difficulties which inventors and discoverers have to struggle against in the preconceived opinions of others.

Flax-cut'ting Ma-chine'. Flax is sometimes cut before hackling in order to enable its separation according to quality. The machine for this purpose has a circular saw which partly cuts and partly tears its way through the bunch of flax which is presented to it by pairs of parallel rollers on each side of the saw.

Flax-pull'er. A machine for pulling flax-plants

Fig. 2018.



Flax-Puller.

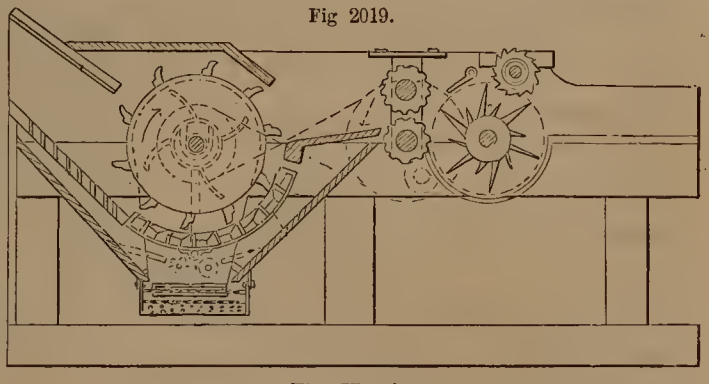
in the field. In the example, the flax passes between a series of dividing fingers, and is seized by the endless rubber belts which are so inclined from the horizontal as to draw the flax from the ground and deposit it on the platform.

Flax-scutcher. See SCUTCHER.

Flax-seed Mill. One for grinding flax-seed for the more ready abstraction of the oil, generally known as linseed (*lint*, flax) oil. It is usually a coarse grist-mill, but is sometimes of a portable form and size for farm or plantation use, and adapted for other grain and seeds. See GRINDING-MILL.

Flax-thrasher. One for beating the grain from the bolls of the cured flax-plant. In the example, the tangled flax is impaled by the spiked roller against the indented roller above, while the drawing rollers straighten the stalk and feed it to the thrashing

Fig 2019.



Flax-Thrasher.

cylinder, which removes the bolls: the latter then fall between the crushing rollers, which release the seed to be cleaned by the vibrating winnower beneath.

The difficulty in thrashing flax consists in its tendency to wrap around the shafts and thrashing cylinder.

Fleam. A spring lancet for bleeding horses.

A gum-lancet. The fleam (phlebotom) was used by the Greeks.

Fleam-tooth. Of a saw. One in the form of an isosceles triangle. A *peg-tooth*.

Fleche. (*Fortification.*) An advanced work at the foot of the glacis, consisting of a parapet with faces forming a salient angle, open at the gorge. It has a communication with the covered way cut through the glacis.

Fleece. 1. The fine web of carded fibers which are removed by the comb or doffing-knife from the doffing-cylinder of a carding-machine.

2. The wool of a sheep in an unbroken mat.

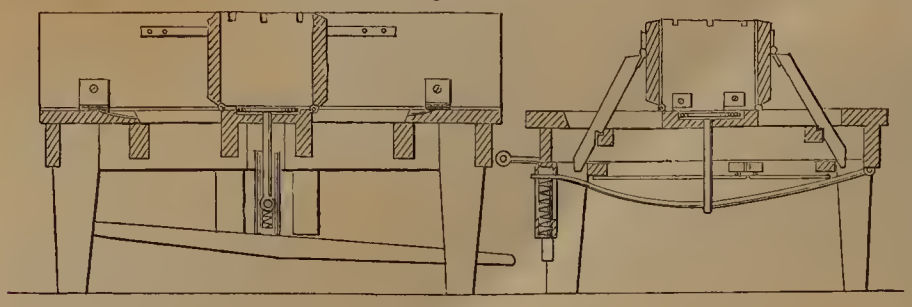
Fleece-fold'er. A kind of press used in condensing the folded fleece so that it may be tied by twine into a compact bundle for shipment. The platform is composed of leaves hinged to a central piece. The wool is laid on the leaves, which are then raised and held in position by notched bars until the package is bound, when they are lowered. A plate, connecting with a spring-balance scale, is placed in the central piece and raised by a lever until the package of wool rests upon it. See WOOL-PACKER.

Fleet. (*Nautical.*) *a.* To draw apart the blocks of a tackle.

b. To allow the cable or hawser to slip on the whelps of the capstan or windlass, from the larger to a part of smaller diameter.

Flem'ish-eye. (*Nautical.*) An eye made at the end of a rope, without splicing. The ends of the strands are tapered, passed over oppositely, marled, and sewed with spun-yarn. A *made-eye*, in contradistinction to a *spliced-eye*.

Fig. 2020.



Fleece-Folder.

Flem'ish-horse. (*Nautical.*) A foot-rope for the man at the earing in reefing. The *horse* extends below the yard; the *Flemish horse* is the outer portion.

Flesh-brush. A soft brush to be used on the skin to promote circulation and excite the surface secretions.

Flesh-hook. A hook to hang meat.

A hook to handle meat in a pot or caldron.

Flesh'ing. (*Leather-manufacture.*) The operation of removing fat, flesh, and loose membrane from the flesh side of skins and hides. The operation follows that of *unhairing*, and is performed on a beam by a convex knife with a sharp edge.

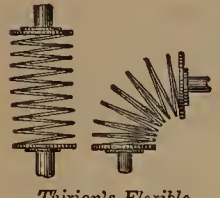
Flesh'ing-knife. A convex knife with a sharp edge used in removing the flesh and fat from the inner surface or *flesh-side* of the hide.

Flews. A sluice for letting waters off irrigated meadows (Scotch).

Flex'i-ble-bind'ing. (*Bookbinding.*) A book sewn on bands raised above the back of the folded sheets, so as to allow them to open more freely. The sewing-thread passes around the bands.

Flex'i-ble-coup'ling. Thirion's flexible coupling is used for conveying power from one shaft to another when they are not in line. It is a spiral steel band attached at its opposite ends to the two shafts to be connected. The diameter of the spiral is larger than that of the shaft, and the attachment is shown as consisting of a cast-iron cap. For a joint of transmission amounting to a right angle, fifteen coils of a spiral will be sufficient. Another form is a cylindrical plug or rod of india-rubber connecting the shafts. See also UNIVERSAL JOINT.

Fig. 2021.



Thirion's Flexible Coupling.

Fli'er. See FLYER.

Flight. 1. (*Carpentry.*) A series of parallel steps proceeding in one direction without turning.

In *dog-legged* stairs, the lower is the *leading* flight, the upper the *returning* flight.

2. The slope or inclination of the arm of a crane or of a cat-head.

3. A spiral wing or vane on a shaft, acting as a propeller or conveyor.

Flight'er. A horizontal vane revolving over the surface of wort in a cooler, to produce a circular current in the liquor.

Flint. A variety of silicious stone used to strike fire; also largely used in making the fine kinds of pottery. Its uses — domestic and for fire-arms — for striking fire are now much abridged among civilized nations. The friction-match and fulminating-powder have superseded the flint and steel.

Flint-glass. This description of glass is made into tumblers and other drinking-vessels, fine table ware and bottles, and various articles of decorative furniture and fittings. It is made of white sand, 52; carbonate of potash, 14; and oxide of lead, 33; alumina, 1; with metallic additions to neutralize color. The articles are made by the agency of the blow-pipe, or ponty, the mold and press, and frequently by a combination of blowing and pressing. The silica for its manufacture was formerly derived from pulverized *flints*, and hence its name. The presence of lead gives it a peculiar property of refracting light, which causes it to be used for lenses, and it forms one of the parts in achromatic compound lenses.

It fuses at a lower temperature than ordinary glass, such as the *crown*, *plate*, or *window* glass. It has also less color, owing to the use of the alkali potash, instead of soda, the latter imparting a greenish tinge to glass.

Flint-glass is softer than some other varieties, and is the kind which is *cut*.

Artificial gems consist of flint-glass, colored in imitation of the natural tints of the gems. See STRASS.

Pure white sand free from oxide of iron is required for flint-glass, as iron imparts a green color.

The Bohemian glass is a silicate of potash and lime, a little of the silicate of alumina being substituted for the oxide of lead. The silica for this glass is obtained by pounding pure white quartz.

Flint-glass work is classed as —

1. Blown.
2. Molded and pressed.
3. Cut and engraved.
4. Reticulated and spun with a variety of colors, incrusted, flashed, enameled of all colors, opalescent, imitation of alabaster, platinized, silvered, etc.
5. Glass mosaic, Millefiori, Aventurine, and Venetian glass weights, etc.
6. Beads, imitation pearls, etc.
7. Glass accessories to lamps, gas-lights, brackets, etc., such as globes, chimneys, drops, bells, reflectors, etc.

Flint-knife. A knife of archæological interest, made from flint chipped to shape.

Flint was very early used as a cutting implement by the nations so fortunate as to possess it. A sort of saw, which passed for a knife, consisted of flakes of flint inserted into wooden handles and secured by bitumen or by lashings of gut or sinews. Obsidian was used in the same way. The South-Sea-Islanders had no flint or obsidian, and used shell, splinters of bamboo, and flakes of tortoise-shell. See KNIFE.

Flint-lock. The old-fashioned lock for fire-arms, in which the cock held a piece of flint and came glancing down upon the steel cap of the pan which contained the priming.

Flint-locks were invented early in the seventeenth century, and gradually superseded the match-lock. Pyrites or marcasite was also used. See GUN-LOCK.

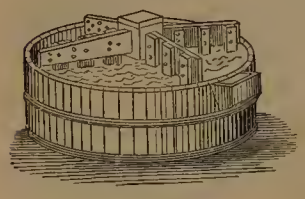
Flint-mill. 1. (*Pottery.*) A mill in which burned flints, having been previously stamped to reduce them below a certain size, are ground to powder for mixing with clay to form *slip* for porcelain.

The flint-mill is a strong circular pan ten or twelve

feet in diameter, having a bottom of quartz or felspar blocks, and a runner or runners of hard silicious stones, called *chert*, lime in any form being inadmissible, as it forms a flux for the other material which would vitrify in the *seggars* or become blistered by the escape of carbonic acid.

The mill is of the nature of an *arrastra*, as the running stones are blocks driven by depending bars from the arms which project radially from the rotating vertical axis.

Fig. 2022.



Flint-Mill.

The fractured flint is fed into the pan, and water to the depth of eight inches is added. The flint is ground by being levigated between the runners and the bed, and by grinding the particles against each other.

The machine resembles the arrastra of Spain and the Spanish countries of America, excepting that in the arrastra the blocks are dragged around in the bed, being connected by thongs to the revolving arms; and also that the argentiferous slimes are treated with mercury in the arrastra, instead of being merely levigated in water. See ARRASTRA.

The flint-pan is the invention of Brindley, so celebrated for his energetic prosecution of the British canals. Before its introduction the flints were ground dry, and the dust proved very fatal to the work-people.

Mills of similar character, on a smaller scale, are used for grinding felspar, broken porcelain, and other ingredients used in the pottery and porcelain manufacture.

2. (*Mining.*) A mode formerly adopted for lighting mines in which flints studded on the surface of a wheel were made to strike against a steel and give a quick succession of sparks to light the miner at his work. Sparks will not inflame the fire-damp.

Flint-wall. A wall common in some parts of England, made of broken flints set in mortar, and with quoins of masonry. The black surfaces of the broken flints are exposed on the face of the wall.

Flint-ware. (*Pottery.*) A superior kind of earthenware into whose composition ground flint largely enters. See PORCELAIN.

Flisk. A large-toothed comb.

Flitch. (*Carpentry.*) *a*. One of several associated planks which are fastened side by side to form a compound beam, or *built-beam*.

b. A bolt of planks, united by the *stub-shot*.

Float. (*Hydraulic Engineering.*) 1. One of the boards or paddles attached to the radial arms of a paddle-wheel or water-wheel.

2. The hollow, metallic ball of a self-acting faucet, which *floats* upon the water in the cistern or boiler. See BALL-COCK.

3. The quill or cork from which the bait line is suspended, and whose motion indicates the bite of a fish.

4. A plasterer's trowel (*a*), used in spreading or *floating* the plaster on to a wall or other surface.

The *long* float is of such a length as to require two men to use it.

The *hand*-float is that in ordinary use.

The *quirk*-float is used in finishing moldings.

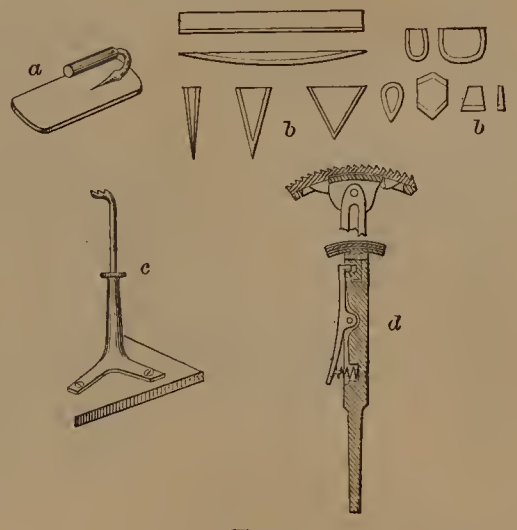
An *angle*-float is shaped to fit the angle formed by the walls of a room.

5. A *single-cut* file, or one in which the teeth are parallel and unbroken by a second row of crossing teeth.

The usual horizontal obliquity of the teeth relatively to the central line of files is 55°, but *single-cut* files are much less inclined, and the teeth of *floats* are sometimes square across the face of the file.

The floats of comb-makers and ivory-carvers are made of various shapes (*b b*), and those of the former

Fig. 2023.



Floats.

are known by specific names, as *graille*, *found*, *carlet*, *topper*. (See COMB.) The teeth have a forward inclination of about 15°, and are made by a file, not a chisel. They are of a lower temper than usual, and are sharpened by a burnisher.

6. The serrated plate (*c d*) used by shoemakers for rasping off the ends of the pegs inside the boot or shoe.

7. (*Tempering.*) A contrivance for affording a copious stream of water to the heated steel surface of an object of large bulk, such as an anvil or die in the process of tempering. The rapid production of steam prevents the constant contact of cold water when the object is merely dipped, as a body of steam intervenes. The dashing stream of water exposes constantly a new body of water to the hot surface, and makes the hardening more complete.

In the English Mint, a powerful jet of water is used in hardening the dies.

8. A coal-cart.

9. A small raft of timber, say 18 feet square and 1 foot deep.

10. A polishing-block used in marble-working. A *runner*.

11. An inflated bag or pillow to sustain a person in the water. A *cork-jacket*. Ormsbee's float is an annular bag placed as a sleeve upon the arm or around the buttocks. It is made of water-proof material, and is inflated when required. See LIFE-PRESERVER.

Float-board. One of the boards of an undershot water-wheel or of a paddle-wheel.

Float-case. (*Hydraulic Engineering.*) A caisson to be attached to a submerged ship or other body, to float it by the expulsion of water and substitution of air in the case.

Float'er. (*Hydraulic Engineering.*) A registering float on a graduated stick to indicate a level attained between periods of observation.

Float'ing. 1. (*Weaving.*) A term applied to a thread which spans a considerable number of threads without intersection. This is an incident to twilling. (See TWILL.) *Diapers*, for instance, are *five-leaf twills*; that is, every warp *floats* under four

threads of woof, and is raised and interwoven with the fifth. Also called *flushing*.

2. The second coat of three-coat plastering.

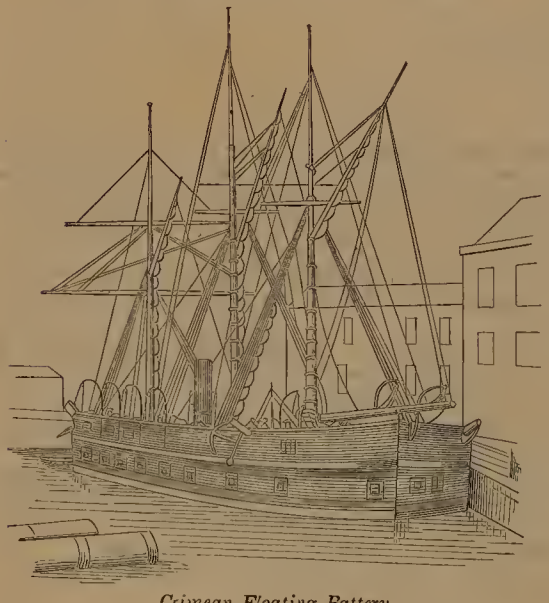
Float'ing-an'chor. (*Nautical.*) A frame of spars and sails dragging overboard, to lessen the drift of a ship to leeward in a gale. A DRAG-ANCHOR (which see).

Float'ing-bat'tery. A vessel strengthened so as to be shot-proof, or as nearly so as possible, and intended for operating in comparatively smooth water, for defending harbors or attacking fortifications.

We are told that a ship of this kind called the "Santa Anna," sheathed with lead, of 1,700 tons burden, carrying 50 guns and having a crew of 300 men, was built at Nice in 1530. She belonged to the Knights of St. John, and was employed by Charles V. against Tunis in 1535.

At the siege of Gibraltar in 1782, by the French and Spanish, ten Spanish war vessels were converted into floating-batteries by strengthening their sides with timber, raw hides, and junk, to a thickness of

Fig 2024.



Crimean Floating-Battery.

seven feet; they were also fitted with sloping bomb-proof roofs or decks, and are said to have mounted 212 guns, principally 32-pounders, which were considered heavy guns in those days; they were manned with more than 5,600 men, and provided with furnaces for heating shot and arrangements for extinguishing fires. They were constructed by D'Arcon, a French engineer, and were first employed in the attack of September 13, 1782, and sustained the heaviest fire of the British during nearly the whole of that day without apparent injury, but were at last set on fire by hot shot.

In 1813, Robert Fulton submitted a plan to the United States government for the construction of a large floating-battery, which was accordingly built; she was 156 feet in length, 56 feet beam, and 20 feet deep, propelled by a single wheel 16 feet in diameter; her sides were very thick, and she is said to have attained a speed of five miles an hour against the tide.

During the Crimean war the French constructed several floating-batteries, which were sent into the Black Sea, and rendered very efficient service at the capture of Kinburn. The English shortly afterwards commenced building vessels of a similar class, but none of these were completed in time to be of service during that campaign.

Those of the French were of wood, and plated with iron four inches in thickness; they were built very flat, but were to a certain extent sea-going vessels.

The English ones, such as the "Erebus," were constructed almost exclusively of iron, and mounted a very heavy battery, consisting of thirty 8-inch guns.

The Stevens floating-battery is a very sharp screw steamer, designed for great speed, and will be found more fully described under the head of ARMOR-PLATING. See also IRON-CLAD; MONITOR; etc.

Float'ing-bridge. 1. A form of ferry-boat which is guided and impelled by chains which are anchored on each side of the river, and pass over wheels on the sides of the vessel, the wheels being driven by steam-power. Lifting platforms at each end admit vehicles.

2. The *floating-bridge* for canals rests on a *caisson* or *ponton*, and is opened and closed by chains and windlasses. When it is open, it lies in a recess in the side of the canal made to receive it. The ponton is made of sheet-iron, and is designed to act as a girder when the bridge is closed.

Bridges across the Hamoaze, Humber, and Itchin, in England, and the bridge which so long crossed the Susquehanna at Havre de Grace, Maryland, are instances of floating-bridges which might almost as well be called ferry-boats; the distinction is not easy to draw, and is not very important. The train ran on to a high deck and was floated across; the differences of level due to tide were met by a hinged trainway.

Float'ing-clough. A barge with scrapers attached, which is driven by the tide or current, to rake up the silt and sand over which it passes, so that the sediment may be removed by the current.

Float'ing-dam. (*Hydraulic Engineering.*) A caisson used as a gate for a dry-dock.

Float'ing-der'rick. One adapted for river and harbor use, in raising sunken vessels, moving stone for harbor improvements, etc. See DERRICK.

Float'ing-dock. An iron vessel of a rectangular shape, with a rounded bow and a strong caisson gate at the stern. The vessel has a double skin, with a large intervening space. Into the inner basin a ship is floated while the dock is partially submerged; the caisson being closed, the water in the dock and in the space intervening between the two skins is pumped out, so that the interior may be dry, to allow work on the vessel, and the jacket may have sufficient flotative power to carry its load.

The estimated proportions of the inner and outer skin are: the latter should be one third broader and deeper than the former. The intervening space is divided by bulk-heads.

The weight or unloaded displacement is estimated at $\frac{5}{10}$ to $\frac{6}{10}$ of its load displacement, giving from $\frac{5}{10}$ to $\frac{4}{10}$ for its lading.

The largest vessel — for such it is — of this class is the "Bermuda," built in England and navigated to the Bermudas, being towed by two war vessels by way of Madeira, where there was a relay of tugs. This dock cost $1,250,000, and is represented on the opposite page. It has the following dimensions: extreme length, 381 feet; width inside, 83 feet 9 inches; width over all, 123 feet 9 inches; depth, 74 feet 5 inches. The weight of the dock is 8,350 tons.

The dock is U-shaped, and the section throughout is similar. It is built with two skins fore and aft, at a distance of 20 feet apart. The space between

THE ENGLISH FLOATING DOCK "BERMUDA."

PLATE XIX.

See page 884.

the skins is divided by a water-tight bulk-head, running with the middle line the entire length of the dock, each half being divided into three chambers by similar bulk-heads. The three chambers are respectively named "load," "balance," and "air" compartments. The first-named chamber is pumped full in eight hours when a ship is about to be docked, and the dock is thus sunk below the level of the horizontal bulk-heads which divide the other two chambers. Water sufficient to sink the structure low enough to admit a vessel entering is forced into the balance chambers by means of valves in the external skin. The vessel having floated in, the next operation is to place and secure the end caissons, which act as gates, and eject the water from the "load" chamber. Then the dock with the vessel in it rises, the water in the dock being allowed to decrease by opening the sluices in the caissons. The dock is trimmed by letting the water out of the "balance" chamber into the structure itself. The inside of the dock is cleared of water by valves in the skin, and it is left to dry. When it becomes necessary to undock the vessel, the valves in the external skins of the "balance" chamber are opened in order to fill them, and the culverts in the caissons are also opened, and the dock sunk to a given depth. From keel to gunwale nine main water-tight ribs extend, farther dividing the distance between the two skins into eight compartments. Thus there are altogether forty-eight water-tight divisions. Frames made of strong plates and angle-iron strengthen the skins between the main ribs. Four steam-engines and pumps on each side—each pump has two suctions, emptying a division of an "air" chamber—are fitted to the dock, and these also fill a division of the "load" chamber. When it becomes necessary to clean, paint, or repair the bottom of the dock, it is careened by the weight of water in the load chambers of one side, and the middle line is raised about five feet out of the water.

The "Royal Alfred," bearing the flag of the admiral on the station, and weighing 6,000 tons, was lifted by this dock, her keel resting on a central line of blocks arranged on the floor of the dock, the ship being shored up with timbers all round the top-sides.

A similar dock was sent in sections to Carthagena, and lifted several vessels of from 3,800 to 5,600 tons, in one case (the "Numancia") supporting the vessel eighty days.

Float'ing-har'bor. A breakwater of cages or booms, anchored and fastened together, and used as a protection to ships riding at anchor to leeward.

Float'ing-light. 1. A light exhibited at the mast-head of a vessel moored on a spit or shoal where no adequate foundation exists for a permanent structure. The *screw-pile*, in affording a new means of founding structures, has enabled light-houses to supersede floating-lights in numerous cases. A *light-ship*.

2. A life-preserving buoy with a light to attract the man overboard, and to direct the crew of a boat coming to his rescue.

Float'ing-plate. (*Stereotyping.*) A flat cast-iron plate placed at the bottom of a square cast-iron tray in which a stereotype is cast. The plaster mold is laid, face down, on the *floating-plate*, and the two are placed in the heated *dipping-pan*, the cover of which is screwed on. The *dipping-pan* is plunged in an iron pot containing the molten alloy, which runs in at the gates and floats the plate and mold; the latter has notches at its edges, which allow the metal to penetrate between it and the plate. The result is a casting with a flat back, and a face with cameo impression resembling the original type.

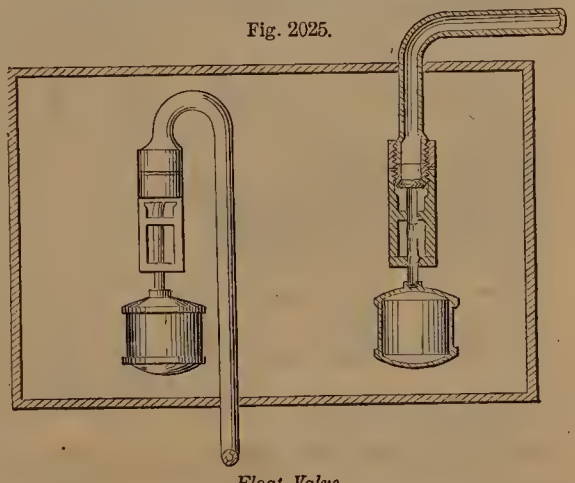
Float'ing-safe. A buoy-shaped receptacle for papers, letters, and valuables, to be cast overboard in case of foundering or wreck.

Float'ing-screed. (*Plastering.*) A strip of plastering first laid on to serve as a guide for the thickness of the coat.

Float-stone. (*Bricklaying.*) A rubber used by bricklayers for smoothing compass-bricks for curved work, such as the cylindrical backs and spherical heads of niches. It takes out the axe-marks acquired in roughly dressing to shape.

Float-valve. A valve actuated by a float so as to open or close the port, according to the level of

Fig. 2025.



Float-Valve.

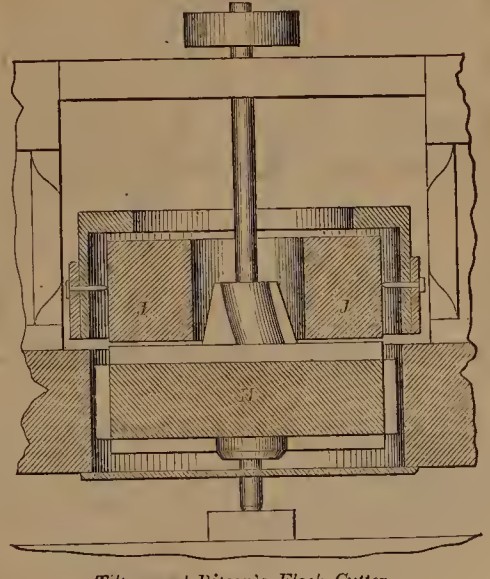
the liquid in the chamber where the float is placed. It is the equivalent of a *ball-cock*.

Flock. 1. Wool-dust used in coating certain portions of the patterns in wall-papers. The wool is the short refuse of the factory, much of it being derived from the cloth-shearing machine. It is scoured, dyed, dried, and ground, sifted into grades, and dusted over the varnished surface of the paper.

2. A fibrous material for stuffing upholstery, mattresses, etc. It is made by reducing to a degree of fineness, by machinery, coarse woolen cloths, rags, tags, old stockings, etc.

Flock-cut'ter. A machine for cutting fiber to a very short staple, called *flock*.

Fig. 2026.



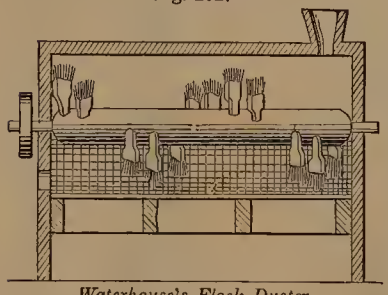
Tilton and Ritson's Flock-Cutter.

In Barber's patent (1846) it consists of a cylinder with spiral knives rotating in contact with a concave having straight knives, the effect being a shear cut upon the fiber passing between the edges, which shave past each other. See also Chase, 1862; Pitts, 1856; Marble, 1872.

The example (Fig. 2026) has a bed in which knives are arranged in parallel groups, of which one in each group is radial and the others of the group parallel therewith. The lower cutter *H* has a rotary motion and a vertical adjustment. The other cutter *J* has a self-adjusting movement, without rotation, but floating, as it were, on the surface of the runner.

Flock-dust'er. For removing dust from flock. The material is agitated by beaters in a gauze cylinder with interior ribs; or it is fed into the hopper at one end of the case and is discharged at the other end, being dusted and loosened by the inclined brushes which impel it forward. The dust escapes through a semi-cylindrical screen.

Fig. 2027.



Waterhouse's Flock-Duster.

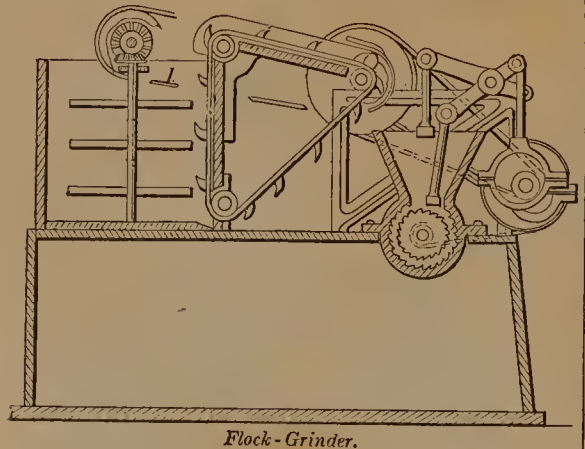
Flock-grind'ing Ma-chine'. A case of the form of a hollow cone, containing a revolving cylinder of the form of the frustum of a solid cone. Both are provided with spirally arranged knives, held between segmental binder-plates. Apertures at both ends are provided, so that the machine may be fed and run in either direction, to sharpen the knives and grind at the same time.

M'Allister s, 1870, has a cylinder of oblique blades operating upon vertical parallel blades on the concave beneath.

In some cases the grinder is a frustum of a cone discharging at the base.

In the example (Fig. 2028), the box has radial agitators on a vertical, rotating shaft. The endless apron passes up one side, and has cups carrying up the material and conveying it to the hopper of the tearing cylinder. The material is forced down upon the tearing cylinder by reciprocal plungers.

Fig. 2028.

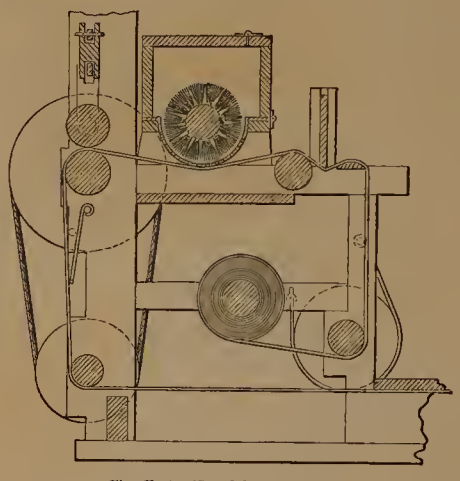


Flock-Grinder.

Flock'ing-ma-chine'. One for distributing flock on a prepared surface of cloth or paper.

In the example, the cloth is passed on an endless web with its varnished side uppermost, beneath a brush whose upper portion rotates in a box of flock.

Fig. 2029.



Chaffee's Flocking-Machine.

Flock-o'pen-er. A machine with pickers or stiff brushes for tearing apart the bunches of flock, so as to make a light, loose fiber which shall feed regularly to the cloth or paper to whose varnished surface it is to be attached.

Flock-pa'per. Wall-paper on which pulverized wool is attached by size.

Flog'ging-chis'el. A chipping-chisel of large size, used in chipping off certain portions of a casting.

Flog'ging-ham'mer. A hammer used by machinists, etc., intermediate in size between the sledge and hand hammer.

Flood-fence. 1. One anchored to prevent its being upset, floated off, or carried away during time of high water; or,

2. One which is laid over by the force of the current, and is prevented by its moorings from being carried away.

Flood-flank'ing. (*Hydraulic Engineering.*) A mode of embanking with stiff, moist clay, which is dug in spits, wheeled to the spot, and then each spit, separately being taken on a pitchfork, is dashed into its place so as to unite with the spit last thrown. The crevices which appear after the contraction of the clay in drying are filled by *sludging*.

Flood-gate. 1. A tide-gate or sluice.

2. *a.* A gate or sluice-door in a water-way, arranged to open when the water attains a hight above a given level, and so allow it to escape freely, to prevent injury by flood.

b. A gate which lies down when the stream becomes deep and powerful, so as to avoid being carried off.

Systems of irrigation including flood-gates, wheels, and pumps, were introduced into Spain by the Saracens. The country is gradually drying up. In the time of Pliny it was more populous and prosperous than now. Since the time of Abderrahman it has become still more dry and sterile.

Flook'an. (*Mining.*) The shifting of a vein or lode by a cleft. *Flooking.*

Floor. 1. (*Building.*) The surface on which a person walks in a room or house.

It may be of masonry, bricks, tiles, concrete, earth, boards.

The term usually refers to boards laid tightly together and nailed to timbers which are termed *joists*.

A *single-floor* (*A*) is one in which the joists *a a*

pass from side to side of the house, resting upon wall-plates and sustaining the floor above, and the ceiling of the room below.

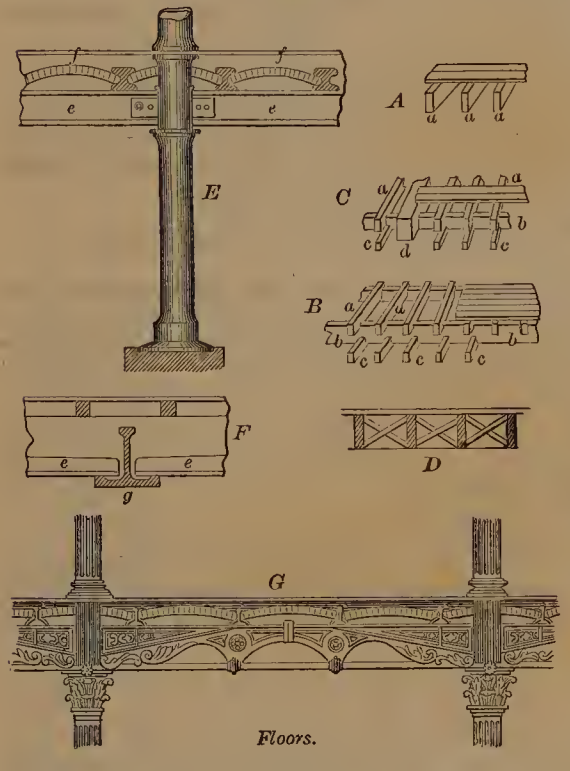
A *double-floor* (*B*) is one in which the primary timbers are binders *b b* which rest upon the wall-plates and support the *floor* or *bridging-joists a a* and the *ceiling-joists c c*.

A *framed floor* (*C*) has an additional member, which assumes the primary position. The *girder d* rests on the *wall-plates* and supports the *binding-joists b*, whose ends rest thereupon. The *binding-joists* support the *bridging* or *floor-joists a* and the *ceiling*-joists *c*, as before described.

Diagonal cross-pieces nailed between the top of one joist and the bottom of the next are called *struts*, and the floor is said to be *strutted* (*D*). The effect is to prevent the lateral deflection or tilting of the joists, and to make them mutually sustaining when an excessive weight is imposed on one or more.

Fire-proof floors (*E*) are usually constructed with iron girders *e* a short distance apart, which serve as

Fig. 2030.



Floors.

abutments for a series of brick arches *f*, on which either a wooden or plaster floor may be laid.

F is a floor with beams *e* supported on iron girders *g*. *G* is a fire-proof floor of brick and cement, supported on iron framing on iron columns. Over the cement is a wooden floor for comfort. It is from the Harpers' establishment in New York.

See also STABLE-FLOOR.

A *folding-floor* is one in which the heading-joints of a number are in a straight line.

In a *straight-joint* floor, each board breaks the joint of the preceding.

A floor without girders, joists, or pillars was laid in Amsterdam for a room sixty feet square. Very strong wall-plates were secured in the walls, and the floor consisted of three thicknesses of one and a half inch boards nailed to the wall-plate. The first two courses were separately laid and nailed diagonally across the space and crossing each other at right angles. The next course was laid in the usual manner, square with the building. The floor was thus suspended, and strained from the wall-plates.

Among the modes of constructing fire-proof floors may be cited girders and beams of cast-iron and trusses of wrought-iron. (See. BEAM.) Spanning the intervals between the beams, brick arches are placed, and upon these concrete floors, with a simple covering of boards for comfort or appearance.

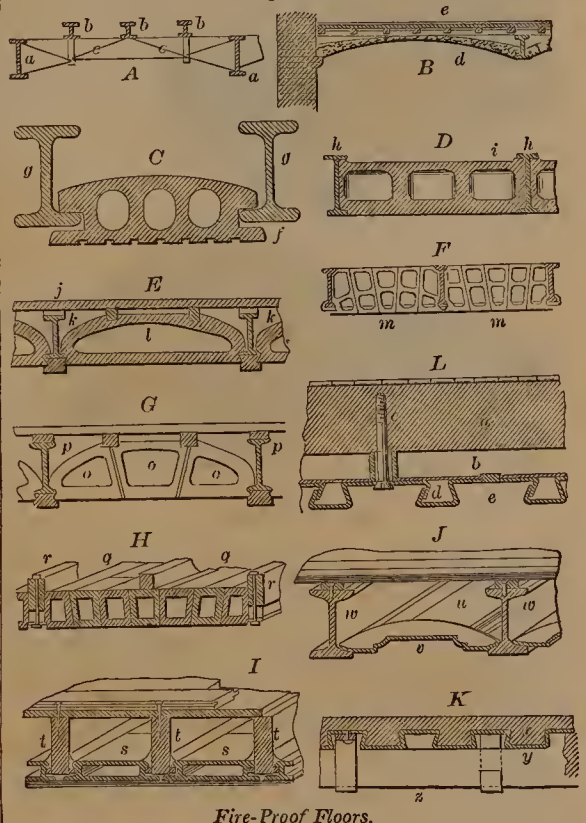
Fig. 2031 shows a number of modes of construction.

A has a truss of three members resting on I-shaped iron girders *a*, and supporting similarly shaped joists *b*, on which a floor is laid.

B has a sprung arch *d* of concrete or béton resting on a skew-back on the wall and the foot flange of the iron girder. On it rest the joists and flooring *e*.

C has hollow bricks *f*, which are suspended from

Fig. 2031.



Fire-Proof Floors.

the foot flanges of the angle-iron girders *g*, and support the ceiling.

D has blocks *i* of cement, concrete, or plaster-of-paris cast on temporary molds between the beams *h* and around cores.

E has arched and hollow tiles *l* which rest on the beams *k* and support the floor *j*.

F has hollow tiles *m* which meet above and below the beams. The tiles are in two tiers, and their thrust is sustained by a tension-rod.

G has arched tiles, three voussoirs *o* in a set, and these rest on the beams *p*.

H has five voussoirs *q* forming a flat arch resting on the beams *r*.

I has ceiling tiles *s* suspended from cleats on the ribs *t*.

J has I-shaped girders *w* supporting tiles whose soffits have coffers and moldings.

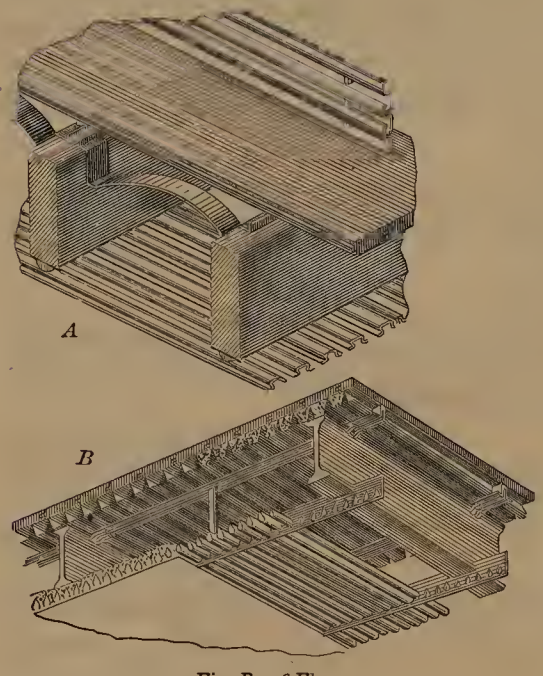
K is a roof in which the concrete surface *x* is held by corrugated plates *y* tied to the rafters *z* by angle-pieces.

L is a similar arrangement for ceilings; *a* the joists, *e* the suspension bolt, *b d* the sheet-iron, *e* the plaster.

In Fig. 2032, *A*, the joists have iron lath, and strips of metal are spiked to the joists to support arches of concrete beneath the flooring. The studding has also metallic lath.

B has girders of iron, with metallic plates for holding the ceiling laths, which are completely covered by the plaster. The floor rests upon con-

Fig. 2032.



Fire-Proof Floors.

crete bedded upon corrugated plates, and these rest upon transverse cross-plates which tie the girders together.

2. The bottom part of the hold on each side of the keelson. The flat portion of a vessel's hold.

3. The inner piece of the two which together form the bucket of an overshot water-wheel. See BUCKET.

Floor-cloth. 1. A heavy painted fabric for covering floors.

The canvas or backing of floor-cloth is a strong textile fabric of hemp or flax, known as *burlaps*. It is woven of a width of from four to eight yards. The pieces of convenient size are stretched in a vertical frame, and size is applied by workmen who stand on ranges of scaffolding in front of the canvas.

It is pumice-stoned to remove asperities. The color for the back is a thick paint laid on with a peculiar trowel. The front is then sized, pumiced, and receives several coats of paint. The pattern was at first stenciled, but since 1780 has been put on with blocks about 18 inches square, one for each color, and the blocks *register* with each other as in calico-printing or paper-staining. The canvas is spread upon a large table. Each block in turn is dipped face downward upon a cushion wetted with paint of the particular color for that block. A layer of paint is thus taken up and transferred to the canvas, as in printing. The colors are applied one by one, occupying their proper places in the pattern, which is made of little square types answering to the pattern and the color.

The *printing-table* is 30 feet long and 4 wide; the roll of painted cloth is underneath it, and is gradually unwound, passing over the surface of the table where the printing-blocks are applied. As it is printed, the cloth slips over the table and hangs down through a slit in the floor, so that it may remain vertical while the paint is drying.

A United States patent has been granted for a printing-block in which each square is represented by a square prism in a chase of the requisite size, say 18 × 18 inches. Each prism is separately movable and may be set out to the plane of the face. Any set of the prisms may be forwarded according to the pattern required.

The art originated with Nathan Taylor, in England, in 1754, at Knightsbridge, near London.

The canvas for the purpose was originally made of ordinary width and the strips sewed together. It was afterwards woven four yards, then seven yards, and eventually nine yards wide.

At the original Knightsbridge factory it is now made in pieces 8 × 20 yards and 7 × 30 yards.

2. An artificial fabric painted, varnished, or saturated with a water-proof material. The kinds are numerous; e. g.:—

Whiting and ocher, mixed with glue dissolved in milk.

Leather scraps treated with alkali, ground, mixed with flax or hemp fiber, and rolled into sheets.

Cotton batting treated with a cement of beeswax, glue, venice turpentine, and boiled linseed oil; covered with a pigment of burgundy pitch, litharge, and boiled linseed oil, colored to suit.

Wall-paper varnished.

Wall-paper on canvas, sized and varnished.

Painted cloth.

Sheets of rubber and cork dust, softened with benzole rolled between two fabrics, a coarse and a fine; the latter is stripped off, leaving the composition attached to the other.

Painted paper.

Duck treated with boiled oil, resin, and cork dust, or saw-dust. Varnished.

Paper printed in oil and varnished with solution of caoutchouc.

Cloth varnished.

Manila paper on both sides of burlaps.

Fabric coated with paper-pulp in the machine.

Roofing-paper treated with warm linseed oil and naphtha, to which is pasted a sheet of wall-paper, varnished.

Burlaps, sheared, damped, calendered, printed.

Paper floor-cloth treated with varnish, having in it powdered felspar or glass.

Fabric covered with paper, treated with oil, resin, and japan varnish. Ornaments of water-color placed thereon and fixed with white glue.

Jute and manila grass combined and colored in stripes.

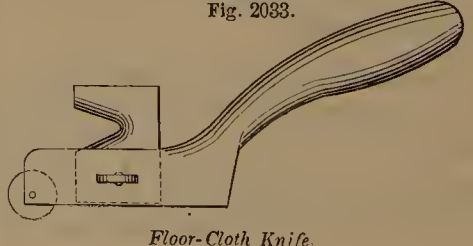
Fabric coated with ground slate or clay; with linseed oil, japan varnish, and paints.

Ground leather, vegetable fiber, and bullock's blood or fibrine, painted, stained, or printed.

Jute fiber printed with aniline.

Canvas sized with glue and painted.

Fig. 2033.



Floor-Cloth Knife.

Lamina of wood backed by fabric or paper.

Paper cemented on cloth, printed or grained, and varnished.

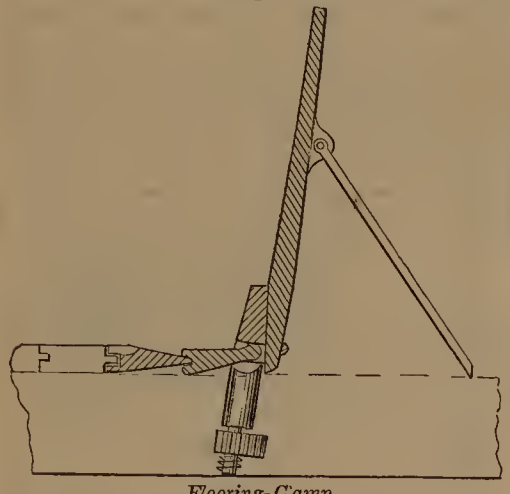
See also LEATHER, ARTIFICIAL.

Floor-cloth Knife. A pushing knife for slitting floor-cloth. The caster keeps it above the floor.

Floor-head. (*Shipbuilding.*) The upper extremity of a floor-timber.

Floor'ing-clamp. An implement for closing up the joints of flooring-boards. In the example, the clamp straddles the joist; is retained by the serrated

Fig. 2034.



Flooring-Clamp.

eams, and the forward thrust of the lever is maintained by a pivoted brace, which engages the joist behind it.

Floor-plan. 1. (*Shipbuilding.*) A longitudinal section, showing the ship as divided at a water or rib-band line.

2. (*Architecture.*) A horizontal section, showing the thickness of the walls and partitions, the arrangement of the passages, apartments, and openings at the level of the principal or receiving floor of the house.

Floor-tim'ber. (*Shipbuilding.*) The lower section of a rib secured between the keel and *keelson*, the flat timbers crossing the keel forming the floor of the hold. The timbers in continuation of the rib are called first, second, third, etc., *futtocks*.

Flop-damp'er. A stove or furnace damper which rests by its weight in open or shut position.

Flo'ran. Fine-grained tin; either scarcely perceptible in the stone or stamped very small.

Flo'ra-scope. A microscope contrived for examining flowers.

Flor'ence-leaf. Fine leaf yellow alloy. See BRONZE-POWDER.

Flor'en-tine. (*Fabric.*) A kind of silk.

Flor'en-tine-re-ceiv'er. A form of receiver (*a*) for the results of the distillation of essential oils. It is conical in form, and has a side spout at which accumulated water discharges as it rises to the level of the bend of the spout, while the oil, which is lighter than water, collects at the top, and may be decanted off.

Fig. 2035.

Florentine-Receiver.

Oils heavier than water are collected in the separator *b* and drawn off at bottom.

Flor'et-silk. FLOSS-SILK (which see).

Flosh. (*Metallurgy.*) A hopper-shaped box in which ore is placed for the action of the stamps. The side of the box has a shutter which is raised or lowered to allow the ore to escape when it has acquired the desired fineness.

Floss. Fluid glass floating in a puddling-furnace.

Floss-hole. (*Metallurgy.*) *a.* A hole at the back of a puddling-furnace, beneath the chimney, at which the slags of the iron pass out of the furnace.

b. The tap-hole of a melting furnace.

Floss-silk. The exterior soft envelope of a silkworm's cocoon; the raveled downy silk broken off in the filature. It is carded and spun for various purposes.

Floun'der. A slicking-tool whose edge is used to stretch leather for a boot front in a *blocking* or *crimping board*.

Flour-bolt. (*Milling.*) A gauze-covered revolving, cylindrical frame or reel, into which *meal* or *chop* from the stones is fed, in order to have the flour sifted through and separated from the offal. The cylinder is large and long, and its axis is usually inclined; the bolting-cloth with which it is covered is of different grades of fineness, the meshes at the reception end being closer than towards the discharge. The matters passing through at the different portions of the length are of different grades, and are kept separate.

The "fine-flour" of Scripture was doubtless bolted flour, in contradistinction to unbolted flour or brown meal.

Pliny speaks of sieves of horsehair as first made by the Gauls, and those of linen by the Spaniards. The method of applying "a sieve in the form of an extended bag to the works of a mill, that the meal might fall into it as it came from the stones, and of causing it to be turned and shaken by the machinery, was first made known in the beginning of the sixteenth century" (BECKMANN). The best bolting-cloths used in Germany, when Beckmann wrote, came from England, and were made of wool.

Flour-cool'er. (*Milling.*) A chamber, trunk, or machine in which meal from the stones is placed to cool, or is stirred by a blast before arriving at the bolt.

Flour-dress'ing Ma-chine'. The flour-dressing machine is a hollow, stationary, inclined cylinder or frame covered with wire cloth of different degrees of fineness, 64, 60, 38, and 16 meshes to the inch, the finest being at the upper end. Within the cylinder is a reel whose rails are covered with brushes, which, in their revolution, act against the interior wire surface of the cylinder. The meal is conducted within the cylinder by a spout or hopper, and is thus rubbed through the wire meshes, the finest at the top, the next at the succeeding grade, and so on. The various qualities are collected in the separate partitions of the box.

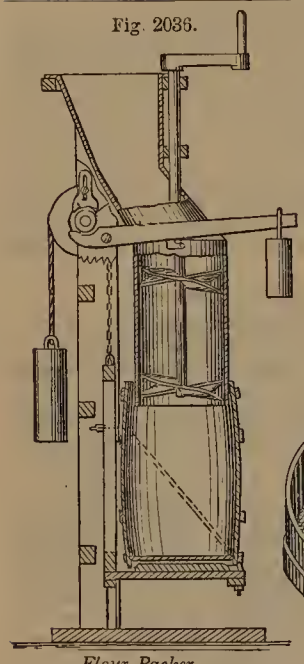
The machine is described in the patent of John Milne, 1675.

Flour-mill. See GRINDING-MILL.

Flour-pack'er. A machine for compactly filling barrels or bags with flour. It is usually a follower or piston which presses upon the flour, but in some cases the flour as it falls into the barrel is continuously packed by a spiral, as in the example.

The barrel is placed on a platform suspended by a steelyard and by a weighted cord passing over a pulley. The steelyard takes under and clamps another pulley attached to the former one, driving it against a block above. On sufficient deposit of flour the steelyard is depressed, the roller freed

Fig. 2036.

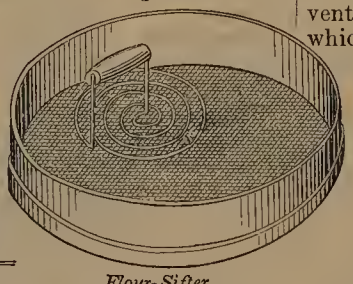


Flour-Packer.

from the upper brake, and the barrel of flour descends.

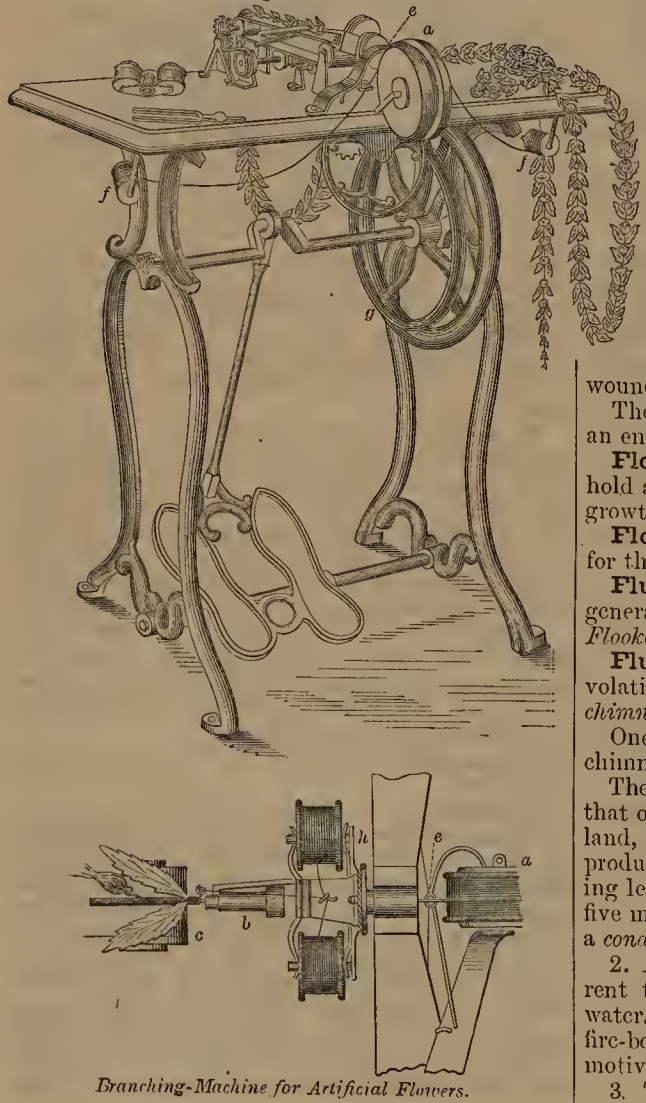
Flour-sift'er. A domestic sieve for separating lumps or accidental trash, such as insects, from the flour of the bin or barrel. As a substitute for the hands, a flat coil of silvered wire is adapted to vibrate over the meshes of the sieve and expel the flour.

Fig. 2037.



Flour-Sifter.

Fig. 2038.



Branching-Machine for Artificial Flowers.

Flow'ers, Ar'ti-fi'cial. Ornaments simulating the natural products of the garden ; made from wire, gauze, cloth, paper, shavings, wax, shell, feathers, etc. Cutting-punches and scissors are used for shaping ; gauffering-presses for stamping into the various graceful shapes and puckers.

The feather-flower makers of South America and Mexico had attained great skill in the time of Cortes. Italy led the way in Europe ; France followed, and now leads.

Fig. 2038 shows a French machine for branching artificial flowers, that is, braiding them or leaves to a stem.

The basis of the stems is wire, and two threads of suitable material are laid along this wire to prevent subsequent slipping of the colored thread, which forms the outer covering of the stems. The ends of the short stems of leaves, flowers, buds, and fruits being laid against the wire are wound under the outer covering, and are thus fastened to it.

The wire is fed from a spool *a*, passes through a hollow spindle *b*, and lies upon an endless feed-belt *e*, to which it is clamped by small pinchers.

The belt is driven by gearing underneath, and carries with it the wire stem, which is slowly unwound from the spool *a*. Two threads, passing through an eye *e*, are also drawn through the hollow spindle *b*, in conjunction with the wire, by the motion of the endless belt. These threads are unwound from the spools *f*. At the same time a rapid rotary motion is given to the hollow spindle by a small belt from the driving pulley *g*.

On the revolving hollow spindle *b* is fixed a spool-frame *h*, which carries two spools. The covering threads are led from these spools through the loop of a small flyer on the end of the hollow spindle *b*, and being held in contact with the wire as the latter is slowly fed through the spindle, are wound uniformly over its surface, the spool-frames revolving with the spindles.

The ends of the stems of leaves, fruits, or flowers being thrust into the ends of the hollow spindle are at once caught, and firmly wound under in a rapid manner.

The upper figure is a general view, and the lower an enlarged view of the principal working parts.

Flow'er-pot. A flaring earthenware vessel to hold a plant with a sufficient quantity of soil for its growth.

Flow'ing-fur'nace. (*Founding.*) Another name for the cupola for melting iron in foundries.

Fluc'can. (*Mining.*) A soft, clayey substance, generally accompanying the cross-courses and slides. *Flookan.*

Flue. 1. A passage for the conveyance of the volatile results of combustion. A *smoke-duct* or *chimney*. See FIREPLACE ; CHIMNEY.

One of a cluster of smoke-ducts in a stack of chimneys.

The longest flue with which we are acquainted is that of the lead-furnaces, Allen Mill, Northumberland, England. It is used for cooling the volatile products of combustion, and condensing the escaping lead fumes. It is 8,789 yards in length (nearly five miles), is 8 feet high, 6 wide. It may be called a *condenser*, so far as the fume is concerned.

2. A pipe for the conveyance of the caloric current through a boiler, to heat the surrounding water. It is usually secured in the sheets of the fire-box and smoke-box respectively, as in the locomotive-boiler. Perhaps invented by Smeaton.

3. The technical abbreviation of *flute ;* used by

organ-builders to signify a *flute-pipe*, in contradistinction to a *mouth-pipe* or *reed-pipe*.

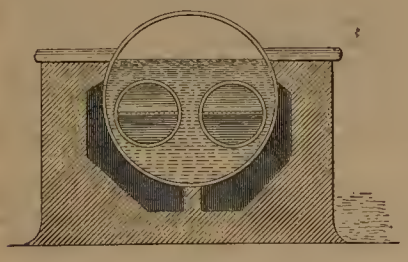
Flue-boil'er. A steam-boiler whose water space is traversed by flues; that is, a tube in which the heated gases are conveyed. There are several varieties, as, *drop-flue; multiple-flue; return-flue*, etc.

Smeaton is credited with the invention. It is now the usual form on our Western rivers; the cylindrical boilers have usually two flues. The fire heat first passes beneath the boiler, and then returns through the flues.

The term *flue*, properly used, distinguishes the boiler from those which have *tubes*, which are full of water, and the heat *surrounds* them, but does not *fill* them.

In the boiler represented, the fire is built *in* the flues, and the caloric current returns beneath the boiler.

Fig. 2039.



Fairbairn's Flue-Boiler.

Fig. 2040.

Flue-Brush.

Flue-brush. A cylindrical brush of wire or steel strips used to clean the scale and soot from the interior of a flue, to lay bare the metallic surface.

Flue-clean'er. A brush of wire or steel slips, or a scraper to clean flue surfaces of steam-boilers.

A device by which a jet of steam may occasionally be projected along a boiler flue to blow out the scale of soot.

Flue-ham'mer. (*Coopering.*) One whose *peen* has a working edge, the length of which is in the plane of the sweep of the hammer. It is used in flaring one edge of each iron hoop to enable it to fit the *bulge* of the cask. See PEEN.

Flue-plate. A plate into which the ends of the flues are set.

Flue-scrap'er. An implement having circular or spiral blades to scrape the scale from the fire-surface of flues of steam-boilers.

Flue-sur'face. (*Steam-engine.*) The area of surface of the boiler which is exposed to the action of the flame and heated gases after they have left the fire-chamber or furnace.

The heating surface of a boiler is made up of the *fire-surface* and *flue-surface*.

Fluid-com'pass. (*Nautical.*) That in which the card revolves in its bowl floated in alcohol.

Fluid-lens. One in which a liquid is imprisoned between circular glass disks of the required curvatures.

Attempts to obtain achromatism have been made by using metallic solutions and other liquids having a higher dispersive power than flint glass. Though several of these liquids appear to have given excellent results experimentally, they have never been brought into general use.

Fluid-me'ter. A device to ascertain the quantity of fluid passing a selected point.

Some of these are driven by clock-work or other motor, others by the pressure of the fluid. When this is an elastic body, as air or gas, the question is complicated by the compressibility; when the fluid is such as water, alcohol, or oil, the problem is more simple. See LIQUID-METER.

Among fluid-meters proper may be cited GAS-METERS (which see). As to mechanical construction, they may be described as fans rotating spiral vanes, expanding bags, cylinder and piston, revolving partially submerged meter-wheels, inverted cylinders. See AIR-HOLDER, etc.

Fluke. 1. (*Nautical.*) The palm of an anchor. The broad, holding portion which penetrates the ground. See ANCHOR.

2. (*Mining.*) The head of a charger; an instrument used for cleansing the hole previous to blasting.

Flume. A chute or penstock, open or covered, for the passage of water to a wheel or washer. Used with water-wheels and gold-washers of various kinds. A *penstock*.

The illustration shows a flume crossing a valley

Fig. 2041.

Flume near Smartsville, Yuba County, California.

in California, uniting the feeder canal on one ridge with the distributing canal of another ridge.

Flu'or-o-type. (*Photograph.*) A process into which fluoric acid enters in the shape of fluorate of soda.

Flush. 1. A term signifying an unbroken or even surface, or applied to surfaces on the same plane.

2. To turn on a sudden dash of water. See FLUSHING.

Flush-bolt. *a.* A screw bolt whose head is countersunk so that it shall not protrude from the surface of the object.

b. A sliding bolt let into the face or edge of a door so as to make an even surface therewith.

Flush-deck. (*Nautical.*) One running the whole length of the vessel, from stem to stern, without forecastle or poop, as in a frigate. The "Great

Eastern" has a flush-deck 692 feet long and 83 feet wide.

Flush'ing. 1. (*Hydraulic Engineering.*) To turn on a sudden and copious dash of water as in *flushing a sewer* to cleanse it of silt. When a collected body of water is turned into the channel of a harbor to deepen it and keep it navigable, it is termed *sluicing;* the *sluice* being opened to let the water out of the reservoir. Where the water of a river is dammed to obtain a fall, and the head of water is turned through a sluice-way to increase the depth of water at that point to float a boat on to another level, it is termed *flashing.*

When the water from a dam is suddenly turned by a sluice-way down a ravine, to turn up the earth and stones and expose ore, it is called *hushing.*

2. (*Weaving.*) A term applied to a thread which spans a number of other threads without intersection. (See TWILL.) Usually called FLOATING (which see).

Flush-joint. One in which the abutting parts make no projection beyond the general face of the object.

Flush-pan'el. (*Joinery.*) One whose surface comes out even with the face of the stile.

Flush-wheel. A wheel used in raising water for draining; it is shaped like a *breast-wheel,* but is *driven* by power to raise water. See SCOOP-WHEEL.

Flute. 1. (*Music.*) An ancient wind instrument which had several forms in ancient times, which it still maintains among savage nations. The New-

Fig. 2042.

Flutes of ancient Egypt and of Brazil.

Zealanders play it with a blast through the nose. In some barbarous countries it has two barrels. The mouth-piece is generally at the end, like our clarinet. Captain Speke found one of the native kings of Equatorial Africa proficient after his style.

The instrument called a flute in the translation of the Book of Daniel may have been the pandean pipes, which are very ancient, or it may have been the flute as used in Egypt.

The flute is very common in the paintings of the Egyptian tombs. The accompanying cut is from a painting in a tomb near the Pyramids. The action indicates the side position of the mouth-pieces and holes. Of the chromatic scale we may learn more from what Pythagoras has written, for no doubt he derived his information from the Egyptian priests, who were scientific musicians.

The flutes of ancient Egypt were single and double; the latter are shown on the paintings of Eléythya. In one case the flute is apparently blown through the nostril, like the New Zealand flute.

Herodotus (450 B. C.) mentions the marching of the troops of Alyattes the Lydian "to the sound of pipes and harps, and flutes masculine and feminine." This has been understood to refer to the sexes of the players, but more probably indicates lower and higher musical pitch.

Flutes among the classic Greeks were made of asses' bones, which are said to be remarkably solid. The euphony of the sound may be presumed to be in the inverse ratio of the natural tone of the original proprietor.

The same much-belied animal contributes his hide to the making of drum-heads, which have a fullness of tone highly suggestive of the inflated style of the creature

"Out of whose mouth there issues a blast."

See DRUM. The *ossea tibia* was made of the leg-bone of a crane.

Alcides *loquitur:*—

"The Alexandrians are especially skillful with the flute; and not only in those kinds called girl's flutes and boy's flutes, but also in men's flutes, which are also called perfect and super-perfect; and also in those which are called harp-flutes, and finger-flutes. For the flutes called *clymi,* which Sophocles mentions in his 'Niobe,' and in his 'Drummers,' we do not understand to be anything but the common Phrygian flute. And these, too, the Alexandrians are very skillful in. They are also acquainted with the flute with two holes, and also with the intermediate flutes, and with those called *hypotreti,* or bored underneath.

"We know of some that are called *half-bored,* which Anacreon mentions:—

'What lust has now seized thus upon your mind,
To wish to dance to tender half-bored flutes?'

And these flutes are smaller than the perfect flutes. I am acquainted, too, with other kinds of flutes, the tragic flute and lysiodic flute [used by the actor personating a female] and the harp-like flute; all which are mentioned by Ephorus in his 'Inventions,' and by Euphranor the Pythagorean in his 'Treatise on Flutes,' and also by Alexon, who wrote another treatise on 'Flutes.' But the flute called *tityrinus* among the Dorians in Italy, and the flute *magadis* [a Lydian instrument], sends forth a sharp and a deep note at the same time, as Anaxandrides says in his 'Armed Fighter':—

'I will speak like a *magadis,* both loudly and gently.'

And the flutes called *lotus-flutes* are the same which are called *photinges* by the Alexandrians; and they are made of wood growing in Libya. But Juba says that the flute which is made out of the leg-bones of the kid is an invention of the Thebans; and Tryphon says that those flutes which are called *elephan-*

tine [ivory] were first bored among the Phœnicians." — *Deipnosophists*, by ATHENÆUS, A. D. 220.

"The Phrygian *deep-toned flute* had a bell mouth, like a trumpet." — *Ibid.*

So they had no lack of flutes and writers on the same 2,000 years ago.

Flutes are extensively made and used by the Brazilian natives. The bones of which they are made are yellow, jagged, and far from inviting to delicate lips. Their tones, however, are singularly soft and mellow. The largest has two bones, each 12 inches long and ⅝ inch bore. They are united by twine neatly wound and worked. On the back of the lower part are finger-holes, shown in Fig. 2042. The whistle part is constructed by a cone of resinous cement beneath the mouth-orifice, the ridge of cement rising to the center of the tube. The instrument is played by blowing through the upper end, as in a clarinet. A smaller flute is made to play by blowing in at either end. Another has a swelled, wooden mouthpiece, and no side opening. Dual bone-flutes with finger-holes are yet used in the northern provinces of Brazil; besides bamboo flutes and instruments, with which the voices of wild beasts are imitated with singular accuracy.

The Peruvians, among a multitude of musical instruments, had flutes of various sizes, the tambourine, and the *tinga*, a kind of guitar with five or six strings. They had also a *syrinx*, or pan's reed, with eight pipes, — one more than the classical and the modern.

The flute, as we now know it, was long known as the *German flute*, having one end closed by a plug, the mouth-orifice being on the side. The common varieties of this flute have six open holes and a seventh closed by a key, as in oboes, bassoons, etc.

Fig. 2043.

Flute.

Flutes are now made with from seven to ten keys, by which the fingering of many musical passages is much facilitated.

Flutes are made of hard wood, ivory, glass, metal, or vulcanized rubber.

In the Smithsonian Institute, Washington, is a Guiana native flute made of the thigh-bone of a tiger.

Vaucanson's automaton flute-player was a life-sized figure dressed in the habit of the period (1730), and standing on a pedestal. The figure and the stand were filled with the machinery. The figure was wound up with a key, and played music on a real flute. Air was emitted at the mouth of the figure and projected into the mouth-hole of the flute. The force of the blast was proportioned to the loudness or softness required, and we presume the size and perhaps shape of the embouchure formed by the lips was varied according to the pitch and perhaps the timbre. The details of the invention in this respect have not come down to us. The fingers were made of some elastic material, and were made to stop the holes in the order required. The compass of the machine is not stated, nor the number of tunes within its repertoire.

In a flageolet-player subsequently made by the same artist, the number of holes was but three, and the variation of the pressure on the bellows was from one ounce for the lowest to fifty-six pounds for the highest.

About 1820 two automaton flute-players were exhibited in London. They played eighteen duets.

2. (*Architecture.*) *a.* A long vertical groove in the shaft of a column.

It is usually circular in section, but, when angular, the shaft is called a *canted* column.

The Doric column has twenty flutes.

The Corinthian, Ionic, and composite have each twenty-four flutes.

The Tuscan none.

b. A hollow, concave chamfer, gutter, groove, or channel; the receding member of a compound molding.

3. A species of ruffle.

4. A *stop* in an organ.

Flute-bit. A wood-boring tool adapted to be used in a brace, and used in boring ebony, rosewood, and other hard woods. See BIT; BORING.

Flute-or'gan. (*Music.*) An organ in which the sound is produced by the action of wind on a cutting edge, in contradistinction to the *reed-organ*, in which the sound is produced by a vibrating tongue of metal. See REED-ORGAN.

The *flute-pipe* has a hollow *foot* to conduct the wind to the *body*, which is fastened thereto. Between the *foot* and the *body* is a diaphragm with an aperture through which the wind escapes, coming in contact with the upper lip of the mouth and being set in vibration, thereby causing the sound As in the flute, the quality of the sound is governed by the proportions of the pipes.

The pipes are made of metal or wood, are generally cylindrical and open at the end.

The wooden pipes are square in section, their ends being stopped with *tompions*, whose distance from the lip modulates the tone, as in the flute.

The longer the pipe the graver the sound, — like the flute again, as may be observed by blowing it after stopping all the side holes in the flute with the fingers, and again after raising the fingers.

The *flute-organ* is also called the *mouth-organ*, and the *mouth* or *flute pipes* are technically known as *flues;* a contraction of *flutes.*

Flute-pipe. (*Music.*) An organ-pipe having a sharp lip or *wind-cutter* which imparts vibrations to the column of air in the pipe, producing a musical note. See MOUTH-PIPE.

Flute-stop. (*Music.*) A stop of an organ in unison with principal, and tuned one octave above *open-diapason.* See STOP.

Flu-ti'na. A kind of accordeon resembling the concertina.

A form of melodeon. An instrument worked by a bellows and keys in bank, and having one set of reeds.

Flut'ing. 1. A species of ruffle.

2. One of the longitudinal grooves in a screw-tap, giving cutting-edges to the thread. See FLUTE.

Flut'ing-cyl'in-der. One having longitudinal grooves to corrugate, crimp, or flute thin sheet-metal plates or fabrics.

Flut'ing-i'ron. A species of laundry-iron which flutes the clothes. In the example, the iron has a segmental corrugated face, and works upon a flat corrugated bed.

Fig. 2044.

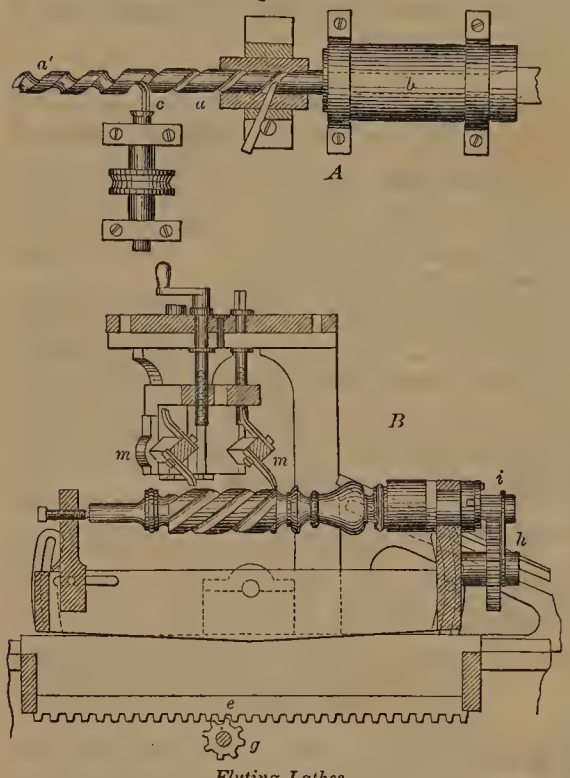
Fluting-Iron.

An *Italian*-iron; a *gauffering*-iron.

Flut'ing-lathe. One which cuts flutes or scrolls upon columns or balusters. The *flute* proper is the vertical groove in a

column or pillar, but the flute of the lathe is a spiral. Several forms of machines are adapted to this purpose. One is allied in its principle to the rifling-machine, as in January's patent, 1829. The baluster is fed endways against a lateral tool, being rotated on its axis at such a rate as shall impart the number of turns or part of a turn to the foot in length. Of this kind is Fig. 2045 (*A*), in which the piece *a*

Fig. 2045.



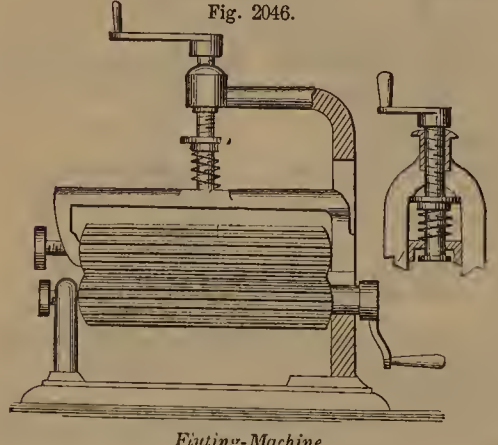
Fluting-Lathes.

to be cut is moved longitudinally through the holder *b*, and at the same time is rotated so that the tool *c* in its revolutions may cut the spiral groove shown at *a'*.

B is a fluting-lathe in which a pair of cutters revolves in a plane oblique with the line of motion of the baluster. The latter is moved longitudinally by the rack and pinion *e g*, and rotated by the wheel and pinion *h i*; the cutters *m m* rotating in parallel planes cut two groves at once.

Flut'ing-ma-chine'. One having a pair of rollers, each one having projections which enter the interdental spaces of the other. By turning the operating screw, the bent bar, and with it the upper

Fig. 2046.



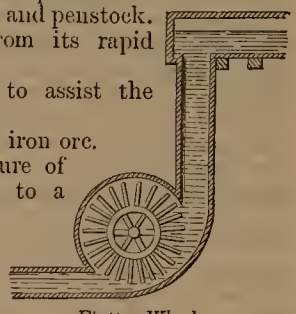
Fluting-Machine.

roller, can be adjusted up or down at will to regulate the distance between the two rollers.

Flut'ing-plane. (*Joinery.*) A plane adapted to cut grooves.

Flut'ter-wheel. A water-wheel of moderate diameter placed at the bottom of a chute so as to receive the impact of the head of water in the chute and penstock. Its name is derived from its rapid motion.

Fig. 2047.



Flutter-Wheel.

Flux. A salt added to assist the fusion of a mineral.

Limestone is used with iron ore.

Crude flux is a mixture of niter and tartar added to a metal in the crucible.

White flux is obtained by projecting, in small portions at a time, equal parts of niter and tartar into a red-hot crucible.

Black flux has double the proportions of tartar, and the resulting product is dark colored.

Mowean's flux consists of pulverized glass, 16 parts; calcined borax, 2 parts; charcoal, 1 part.

Lime acts as a flux, when in excess, in brick-making.

Lime, soda, potash, lead, borax, are used as fluxes in glass-making.

Fluor-spar is used in certain metallurgic operations.

The fluxes used by solderers are, —

Borax.	Venice turpentine.
Sal-ammoniac.	Tallow.
Chloride of zinc.	Gallipoli oil.
Resin.	

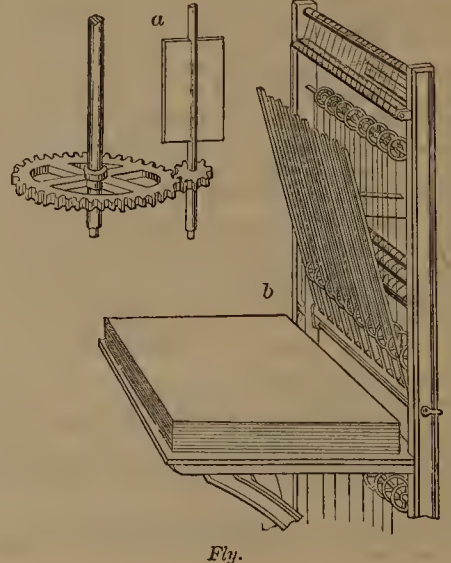
Flux-spoon. (*Metallurgy.*) A small ladle for dipping out a sample of molten metal to be tested.

Fly. 1. (*Horology.*) A regulating device (*a*) used formerly in clocks, and latterly in musical boxes, to control the rate of speed.

The vanes impinge upon the air and meet with a resistance depending upon their area, radial width, angle, number, and speed. By changing these conditions, or any of them, the rate of going of the machine may be regulated; the resistance of the air increasing in a very rapid ratio.

The device is still used in the striking parts of clocks and watches.

Fig. 2048.



Fly.

In musical boxes the position of the wings is adjustable, so as to vary their angle of impact upon the air, thus increasing or diminishing the resistance of a given surface of wing and modifying the speed.

This regulator was probably the first device attached to the going works of a clock, many centuries before the oscillating arm or the pendulum were adapted to the purpose. See PENDULUM.

Among the clocks thus regulated may be cited that of Richard of Wallingford, abbot of St. Albans, A. D. 1380. It is likely that the clock erected in the Old Palace-Yard, London, in 1288, and that of Canterbury Cathedral, A. D. 1292, were similarly constructed. To go a step farther back, we may suppose that the clocks presented by Pope Paul I. to Pepin of France, A. D. 760, and to Charlemagne by the Caliph Haroun Al Raschid, A. D. 810, were of similar construction ; or perhaps were clepsydras.

2. (*Printing.*) A vibrating frame *b* with fingers, taking a printed sheet from the *tapes* and delivering it on to the heap.

3. (*Knitting-machine.*) Another name for the LATCH (which see).

4. (*Spinning.*) The arms which revolve around the bobbin in a spinning-frame, to *twist* the roving or yarn which is wound on the bobbin. See FLYER.

5. (*Machinery.*) A FLY-WHEEL (which see).

6. (*Weaving.*) A shuttle driven through the shed by a blow or jerk.

7. *a.* The length of a flag from the staff to the outer edge. The perpendicular hight is the *hoist.*

b. The part of a flag beyond the *jack*, which occupies the upper left-hand corner. See FLAG.

8. (*Nautical.*) A compass-card having marked upon it the points or rhumbs, thirty-two in number. The card is moved by a magnetic-needle beneath. The angle of the ship's course with the magnetic meridian is shown on the marginal plate by a line called the *lubber's line.* See MARINER'S COMPASS.

9. A kind of carriage ; usually a closed vehicle plying for hire and drawn by one horse.

10. A certain part of theatrical stage scenery.

11. The swinging weighted arm of some kinds of presses. See FLY-PRESS.

12. A factitious insect as a bait for fish in angling. A *hackle.*

Fly-block. (*Nautical.*) A large flat block, double or single. The double block sometimes has two sheaves at one part and one sheave in the other portion. Used in the hoisting-tackle of yards.

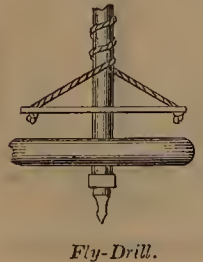
Fly-board. (*Printing.*) The board upon which the printed sheets are laid by the *fly.*

Fly-boat. 1. A rapid passenger-boat on canals.

2. A large, flat-bottomed Dutch coasting-vessel. An ironical term.

Fly-drill. One having a reciprocating fly-wheel which gives it a steady momentum. The driving power consists of a cord winding in reverse directions upon the spindle as it rotates first in one direction and then in the other.

Fig. 2049.



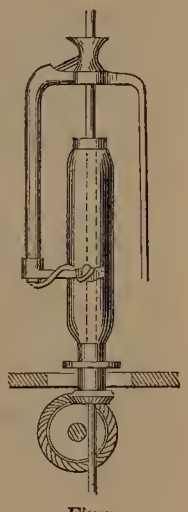
Fly-Drill.

Pressure on the end of the spindle keeps the drill to its work. The fly-wheel pulsates like the balance-wheel of a watch, and as it reaches each end of its stroke the cord has become wound on the spindle, so as to be ready to communicate the impulse in the other direction, by a pressure on the bar which unwinds the cord by rotating the spindle. A relaxation of pressure on the bar allows the spindle to pass beyond the point of unwinding, and the cord winds upon it in a reversed spiral.

This drill may be run by a bow.

Fly'er. 1. A contrivance with arms which revolves around the bobbin in the *bobbin and fly* frame, or the *throstle-frame*, which machines draw and twist the *sliver* into a *roving*, or the latter into *yarn.*

Fig. 2050.



Flyer.

The *flyer* fits on to the top of the spindle, and one arm (in the *bobbin and fly* frame) is made hollow to form a passage for the yarn, which enters at the cup above the top of the spindle, and after a turn or two round the end of the arm is distributed on the bobbin. In the throstle-frame the roving entering above is wound *round* the arm of the *flyer*, instead of passing *through* a *tubular* arm. See THROSTLE.

The flyer rotates with the spindle, and their rotation gives the twist to the yarn. The bobbin is independent of the spindle motion, but in roving-machines has a surface motion equal to the rate of delivery of the yarn from the drawing-rollers. See ROVING. The same also occurs in the BOBBIN AND FLY FRAME (which see).

In the *throstle*, the winding occurs by the detention of the bobbin, which rests on the *copping-rail*, the bobbin being dragged around by the yarn proceeding from the end of the *flyer*, the resistance to revolution on the part of the bobbin effecting the winding. See THROSTLE ; EQUATORIAL BOX.

2. The fan-wheel on the vane of a windmill cap which rotates the latter as the wind veers. See CAP.

3. A step in stairs that ascend in one inclined plane, without winding.

A straight reach of stairs. A *flight.*

4. (*Printing.*) A vibratory rod with fingers which take the sheet of paper from the tapes and carry it to the delivery-table, the sheet resting flatly against the flyer-fingers by the resistance of the air. See FLY.

Fly'er-lathe. (*Weaving.*) A *lay*, *lath*, or *batten* for beating up the weft into the shed, compacting it. Specifically, it may mean a suspended lathe, as distinguished from the batten in a frame journaled below.

Fly-gov'ern-or. One which regulates speed by the impact of vanes upon the air. A *fly.*

Fly'ing-ar-til'ler-y. Field artillery when the gunners are all mounted ; either on horses, or on the limbers.

Fly'ing-bridge. A temporary bridge, suspended or floating. A military, ponton, or boat bridge. See BRIDGE for varieties.

Fly'ing-but'tress. A structure spanning the roof of an aisle between an outer buttress and the wall of the nave. It assists in resisting the thrust of the roof.

Fly'ing-jib. (*Nautical.*) A sail extended by the flying jib-boom beyond the standing jib.

Fly'ing Jib-boom. (*Nautical.*) An extension of the jib-boom. It is sometimes in one piece with the latter, and sometimes connected therewith by means of a boom-iron, in a manner analogous to that of the jib-boom on the bowsprit.

Fly'ing-ma-chine'. To Dædalus, who is said to have flourished about 1300 B. C., is ascribed the invention of the first flying-machine. Being de-

sirous of escaping from the wrath of Minos, king of Crete, and no method of sea conveyance presenting itself, he resolved to attempt flight through the air, and made accordingly wings of feathers united by wax for himself and his son Icarus. They ascended into the air, and Dædalus arrived safely in Sicily, but Icarus rose too high, and approaching too near the sun, the wax of his wings was melted, and, the uncemented fabric falling asunder, the rash youth fell into the sea and was drowned. Notwithstanding the multiplicity of attempts which have been made to accomplish the feat of rising above the earth by means of wings, Icarus remains a solitary warning of the danger of approaching too near to the sun.

Roger Bacon asserted in his time that there existed a flying-machine; he had never seen it himself, nor did he know any one who had seen it, but he knew the name of the inventor.

In 1709, Gusman, a Portuguese monk, constructed a machine in the form of a bird. He was pensioned for this, and was thus perhaps enabled to rise in the world, which his machine signally failed to do. Not discouraged, however, in 1736 he constructed a wicker basket covered with paper, which rose to the hight of 200 feet in the air, by which he gained at least fame, if not money, for he was afterwards reputed a sorcerer.

It was in 1783 that the Montgolfiers discovered that the lesser specific gravity of heated air created an ascensive force by which heavy objects might be raised through the atmosphere; and in less than a month afterwards hydrogen gas, which had then been known for about seventeen years, was successfully employed in a balloon for the same purpose.

This seemed to render the idea of aërial navigation more feasible, and accordingly Blanchard, one of the earliest aëronauts, on his first ascent from Paris in March, 1784, provided his balloon with wings and a rudder, but found them useless. After this we hear little of attempts to guide or propel balloons through the air until about 1843, when Mr. Monck Mason proposed the Archimedean screw as a motor, and constructed an egg-shaped balloon, which was placed on a wooden frame in the form of a canoe, with an Archimedean screw at one end and an oval-shaped rudder at the other. A model of this machine, set in motion by a screw moved by clock-work, was propelled around a room by this means; but the larger machine appears to have met the fate of all its kindred contrivances.

About the same time, a Mr. Henson, in England, patented a machine consisting of a car attached to a huge, rectangular, wing-like frame, covered with oiled silk or canvas, and to be propelled by a steam-engine in the car working two vertical fan-wheels with oblique vanes; while a frame like the tail of a bird was to act as a rudder, and make the apparatus ascend or descend at pleasure. It did not ascend.

In 1850, a Mr. Bell ascended from Kennington, England, in an "aërial machine" in the form of a prolate spheroid, which, it is said, he propelled by a screw, and steered by means of an apparatus for that purpose, during a flight of nearly thirty miles. If this be so, it must have been probably owing to the serenity of the atmosphere.

During the same year, M. Julien at Paris made a model balloon, shaped like a fish, which was made to move in the air by clock-work operating a pair of wings. The model was four yards long, formed of gold-beater's skin, and filled with gas.

A similar machine on a large scale had been tried in England some twenty years before, and failed, though a model of it had been to a certain degree successful.

Mr. Petin, a countryman of Julien's, projected at the same time (1850) a "system of aërial navigation." Certainly a high-sounding name; but then the machine itself was to be on a large scale. It was to consist of an immense framework 480 feet long, supported by four balloons, each 90 feet in diameter, was to have four parachutes, and a platform for passengers. Two horizontal screws were provided for its propulsion. See BALLOON.

Fly'ing-pin'ion. (*Horology.*) The fly of a clock.

Fly-net. 1. (*Menage.*) A net of meshes, or a fringe of leather strips, to protect a horse from flies.

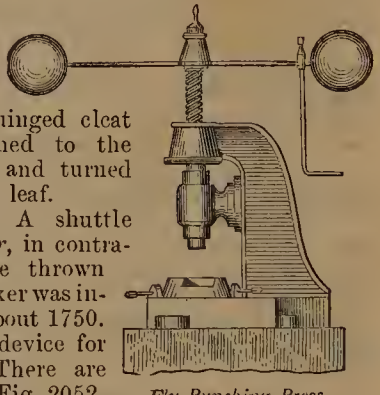
2. A net in an open window to prevent entrance of flies and other insects.

Fly-nut. A nut with wings, to be twisted by the hand; as the screw-nut of a hand-vise.

Fly-press. A screw-press in which the power is derived from a weighted arm, swinging in a horizontal plane, as in embossing and die presses. Presses of this kind are used in making buttons, washers, flat links for chains, cutting and gumming saw-teeth, making percussion-caps, steel-pens, etc.

Fly-punch'ing Press. A press for cutting teeth on saws and for other purposes. The *fly* is the weighted lever, which acquires an impetus in its descent.

Fig 2051.



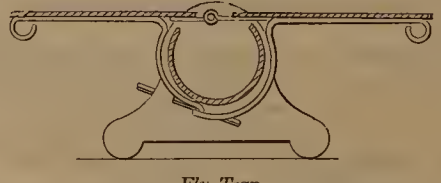
Fly-Punching Press.

Fly-rail. A hinged cleat or bracket attached to the frame of a table, and turned out to support the leaf.

Fly-shut'tle. A shuttle driven by a *picker*, in contradistinction to one thrown by hand. The picker was invented by Kay, about 1750.

Fly-trap. A device for catching flies. There are several forms. In Fig. 2052, the faces of the bait-pans are brought together by spiral springs on the removal of the detent-pin. On separating the pans for resetting, the flies drop into the receiver beneath.

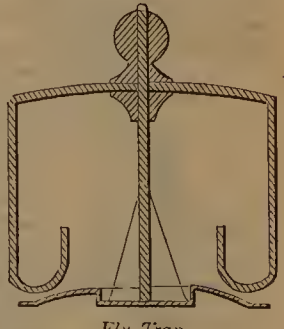
Fig 2052.



Fly-Trap.

Another form is that in which the flies unconsciously walk into a *cul-de-sac*, whence they fail to find a way of retreat.

Fig. 2053.



Fly-Trap.

Other forms have rollers baited and turned by clock-work so as to gradually carry the flies around into the gauze trap or to a position from whence they drop into the drowning-tray.

Fly-wheel. A heavy wheel attached to machinery to equalize the movement. By its inertia it opposes any sudden accelera-

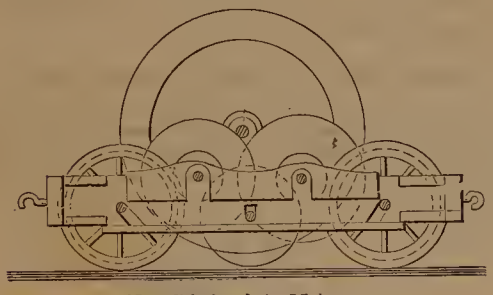
tion of speed, and by its momentum it prevents sudden diminution of speed; in the latter case it acts as a store of power to continue the movement when the motor temporarily flags, or in passing dead centers when the motor is inoperative.

Fly-wheels were first mounted with teeth on their peripheries, to act as first motions, by Fairbairn of Manchester, England.*

The fly-wheel attached to the engine set up at Millwall by Boulton and Watt, for rolling armor-plates, weighs 100 tons.

The *Mahovo* is the name given by the inventor, Captain C. Von Schubersky, of Russia, to an adaptation of the fly-wheel to accumulate a reserve of force to be used at intervals when a greater power is needed.

Fig. 2054.



Von Schubersky's Mahovo.

A pair of heavy cast-steel fly-wheels have an independent truck of their own, which is introduced into the train immediately behind the engine. The truck has three pairs of running-wheels approaching each other very nearly by their circumferences. In the intervals between these wheels are placed two pairs of friction-wheels resting immediately on them; and in the interval between these rests upon their circumferences the large axis of the mahovos; the huge fly-wheels themselves overhanging the truck upon the two opposite sides. When the train moves, the running-wheels impart motion to the friction-wheels, and the latter transfer this movement to the fly-wheels. The diameters of the wheels, and that of the axis of the fly-wheels where it rests upon them, are so related that a velocity of 18.6 miles in the train will generate in the circumference of the fly-wheel a rotary velocity of 466 feet per second; and as the fly-wheels themselves weigh 26 tons, it is computed that, with this velocity, they will embody a living force of 144,000,000 foot-pounds.

As the train moves from rest, the velocity of the fly-wheels is gradually accelerated until it attains a maximum corresponding to the maximum velocity of the train. If steam be now shut off, the fly-wheels become a source of power, and will return the work stored up in them. To stop the train without expending this accumulated force, the friction-wheels are raised out of contact with the driving-wheels. In ascending a grade, the force of the fly-wheels comes in as auxiliary to that of the engine.

Foam-cock. (*Steam-engine.*) A cock at the water-level to blow off scum.

Foam-col-lect'or. (*Steam-boiler.*) A pan or other device at the water-level in the steam-boiler, to catch, retain, and discharge the foam which rises to the surface of the water.

Fo'cal Length. (*Optics.*) The distance between the object-glass and eye-glass of a telescope.

Fo-cim'e-ter. (*Photography.*) An instrument for assisting in focusing an object in or before a camera. This consists usually of a lens of small magnifying power. Formerly, when the fact that the actinic spectrum was mainly outside of the violet end of the spectrum was not properly understood, and lenses were not corrected so as to make the visual and chemical pictures coincident, an instrument was used to determine the amount of movement necessary to throw the actinic picture upon the sensitized plate, subordinating the visual image.

In Claudet's instrument, a number of objects are arranged in a spiral form around the horizontal axis at different distances, so as to be all visible at once from the lens. If, when one of them is in the exact visual focus, another is found to come out more distinctly in the photograph, the discrepancy evidences that the visual and actinic foci do not coincide, and the glass should be rejected.

G. Knight's plan was to place a sheet of negative paper in an inclined position in the camera. A printed sheet being placed before the camera and a picture taken, the relative clearness of the image will determine the true photogenic focus.

Fo'cus-ing-glass. (*Photography.*) A glass used for magnifying the image on the ground glass in the camera, to enable the operator to get it in better focus.

Fog-a-larm'. (*Nautical.*) An audible signal warning vessels from shoals or other dangerous places. Fog-alarms are various in their kind, their operation, and their construction. As to kind, they consist of bells, whistles, and trumpets. As to operation, they are sounded by the current, by the ebbing and flowing tide, by the swaying of the waves, by the wind, by bellows, by clock-work impelled by weight or spring. As to construction, they are adapted for headlands, light-ships, buoys, or to be anchored by piles on spits, sand-bars, or shoals.

A somewhat notable signal of this kind was the bell on the Inchcape Rock, which was placed there by the "good old abbot of Aberbrothock," as sung by Southey in his ballad of "Ralph the Rover." The bell or its clapper was swung by the motion of the waves, and was anchored to the dangerous submerged rock, in the track of navigation in the Frith of Forth. A substantial lighthouse now stands on the rock, which is named from the bell formerly placed on the spot by the courageous, pious monks.

In *A* the apparatus is erected on the deck of a ship which is moored in the position required. From posts on the hull is suspended a pendulous frame which is swung back and forth by the motion of the vessel. A transverse bar in the lower part of the swinging frame actuates the wheel, which is journaled between the pendent arms. Thus the motion of the frame partially rotates the wheel and rings the bell, by means of a band passing over the wheel and over a pulley on the bell-shaft. In *B* the clapper is moved by cam-wheel actuated by chains, which run over pulleys as the float-arm rises and falls by the motion of the waves.

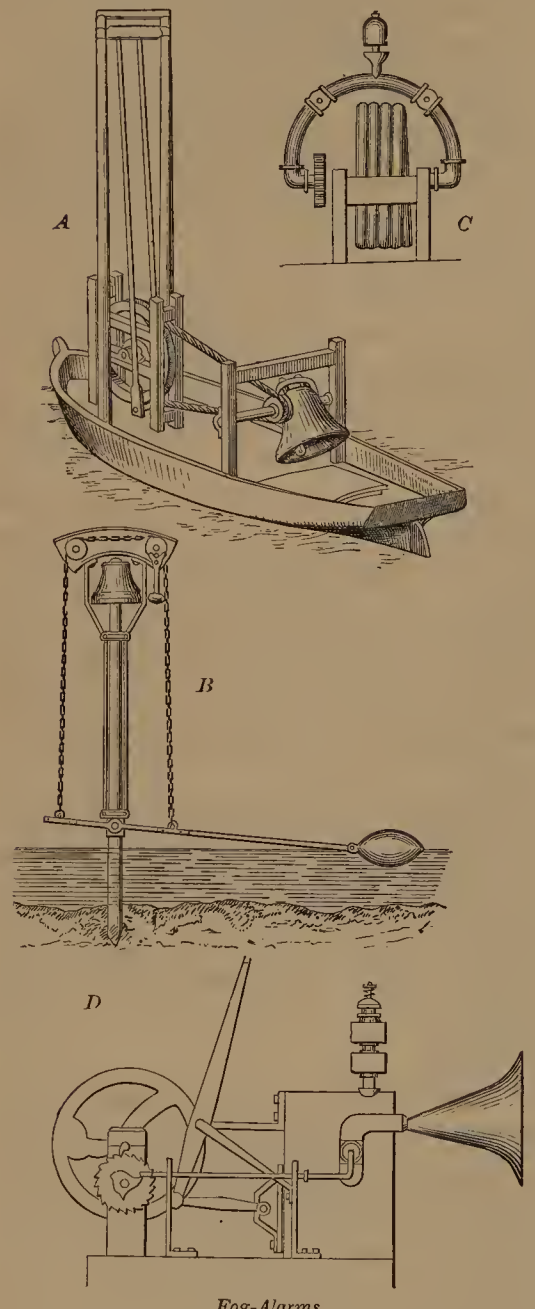
Another form is a bell-buoy with paddles which move the clapper. The clapper of another is moved at regular times by a train of clock-work.

C has a spiral coil of tubing journaled upon standards, and oscillating by the motion of the vessel. Each end of the spiral has a whistle and a valve opening inward. The coil contains a quantity of water, which, as the coil is oscillated, changes its position, and forces the air out through the whistles with a prolonged sound.

In *D* the air is mechanically condensed and stored in a reservoir. The cam on the rotary shaft actuates

the valve for the purpose of varying the sounds, to give a series of audible signals more intelligible than mere independent sounds repeated. A trumpet and whistle are attached to connecting pipes proceeding

Fig. 2055.



Fog-Alarms.

from the reservoir. The valve governs the air-aperture in the pipe leading to the trumpet.

Among other devices may be cited: —

One drives compressed air or steam through perforated, rotating disks or plates. The sound-trumpet has a parabolically shaped extension.

Another has cylinders provided with interior clapper-valves near the heads; these admit air when the water recedes, but prevent its escape at the valve-way when the water rises; the air has its exit through the whistles, and sounds the alarm.

Another has two whistles and a single mouth-piece, the aim being to produce discordant sounds, which arrest attention.

A very large fog-whistle, worked by a ten-horse-power engine, is placed on Thatcher's Island, off Salem, Mass.

Fog-bell. A bell upon a vessel, buoy, or spit of land, and rung by the motion of the waves or force of the wind, as a warning to mariners. See FOG-ALARM.

Foge. (*Mining.*) A forge for smelting tin. (Cornwall.)

Fog-horn. See FOG-ALARM.

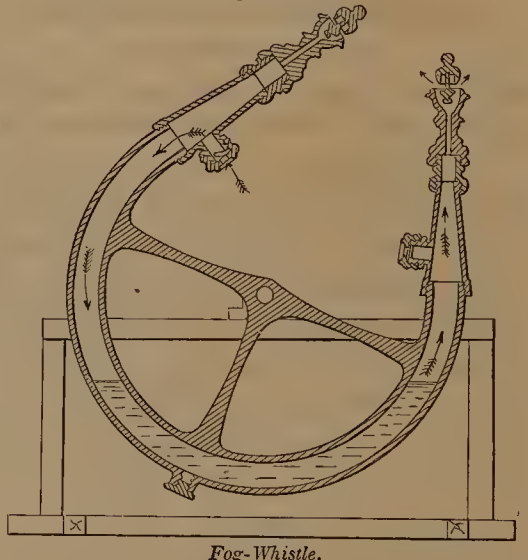
Fog-trump'et. A horn or trumpet placed on a projecting headland, a vessel, or a spar, and blown by mechanical means or by the wind, as a warning to mariners. See FOG-ALARM.

Fog-sig'nal. A detonating ball placed on a railroad track, to indicate danger ahead to the engineer of a passing train.

For nautical, see FOG-ALARM.

Fog-whis'tle. (*Nautical.*) A signal of warning for vessels off a coast. A sounder on the principle of the steam-whistle is exposed to a blast of air or of steam, according to the facilities of operation. Usually, motion derived from the waves, the tide, the wind, or clock-work, make it automatic. In

Fig. 2056.



Fog-Whistle.

the example, the semicircular tubular vessel is mounted upon a rock-shaft, and has at each extremity an ordinary whistle and a valve opening inward. When the vessel is partially filled with water and rocked to and fro, the air is forced through the whistle and sounds an alarm.

On dit: The most powerful fog-whistle in America is at Cape Fourcher, N. S. It can be heard fifteen miles in clear weather, and twenty-five with the wind.

Foil. 1. A thin leaf of metal, for plating, or to color a gem behind which it is placed. A colored foil imparts its tint to a gem whose natural color is vague and insipid.

Foil is made by rolling into thin sheets a plate of copper covered with a layer of silver. The silver surface is polished and covered with a clean varnish, colored or white.

Tin or lead foil are very thin sheets.

2. An amalgam of silver and tin at the back of a looking-glass.

3. A blunt weapon for fencing. A thin blade with a button on the end.

4. A leaf in architecture or carving; as a trefoil ornament; or a window, having lobes like clover.

Fold. 1. A fenced-in inclosure for stock.

2. A doubling of fabric; a *plait;* a *hem.*

Fold'ed-an'gle Joint. See ANGLE-JOINT, Fig. 221.

Fold'er. 1. An ivory or bone blade, used in folding sheets for binding; also in forwarding sheets from the pile in feeding to presses.

2. A form of spectacles in which the lenses fold together for the pocket, and grasp the nose by a spring bow or stiff joint when in use.

Fold'ing. The process by which printed sheets are so doubled up as to bring the pages into consecutiveness for gathering and binding.

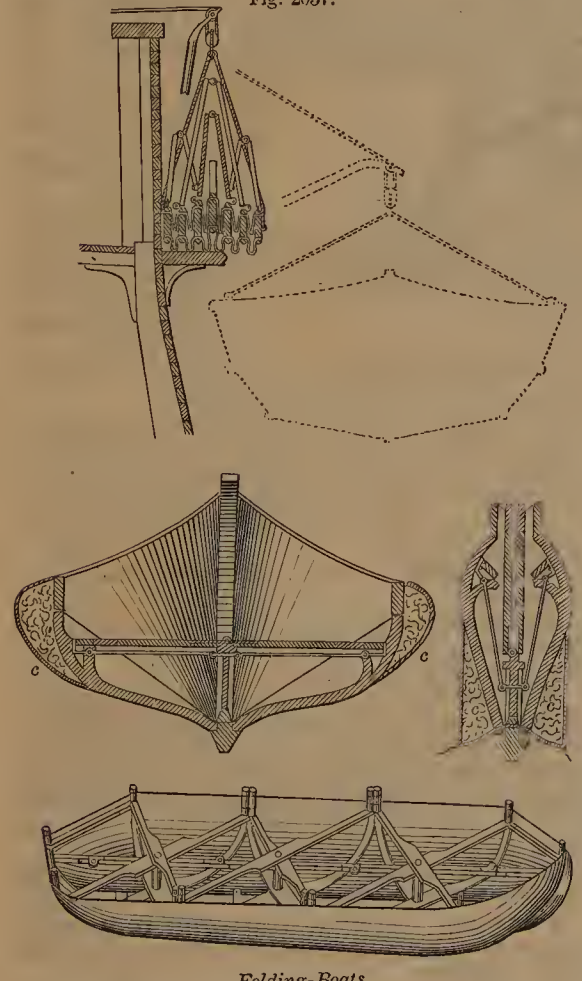
Sheets are of varying sizes, as *demy, medium, royal, imperial,* etc.

The number of pages to each side of the sheet is indicated by the name 4to, 8vo, 12mo, 16mo, 24mo, 32mo, 48mo. The *folio* sheet has two pages on each side and is once folded.

The size of the book will therefore depend upon the size of the paper and the number of times it is folded. Each distinct sheet of a book has a certain mark, called a *signature.* These are *gathered* consecutively to form the book.

Fold'ing-boat. One whose frame is collapsible for compact stowage, either on shipboard or for

Fig. 2057.



Folding-Boats.

transportation on land. In a military point of view, the folding-boat may be used for crossing streams or reconnoitering, or it may be for use as a bridge ponton. Such boats are also used by sportsmen who travel a distance to meet aquatic game, finny or feathered, on coast, lake, or river.

The illustrations show several kinds, and a score more might be readily given would room permit. The upper one is a davit-boat, which lies compactly against the ship's side until the toggle-frame is extended, and the elastic skin distended thereby. It is then swung clear and lowered.

Next are two views, in the extended and collapsed forms respectively, of a boat whose sides are hinged to the keel, and whose stem and stern may be laid over towards the midship section in a similar manner, though this does not appear in the engraving. *c c* are bags of cork which are pendent in the collapsed form, but are caught up against the gunwale when the boat is ready for duty.

The lower figure has a frame which may be folded up to the length of the ribs, and a width equal to the thickness of the ribs when laid up close together. In use, a skin of sufficiently tough waterproof material is stretched over the extended frame. See also LIFE-BOAT.

Fold'ing-chair. A chair which is collapsible for carriage or stowage. One of the examples is a

Fig. 2058.

Folding-Chairs.

library-chair. Another is a camp-chair in two positions. The lower one is in its most prolonged form, and is a lounge.

Fold'ing-door. A pair of doors hung from opposite sides of the aperture, and meeting midway of the passage.

Fold'ing-ma-chine'. 1. A machine for folding printed sheets for books; or newspapers for mailing.

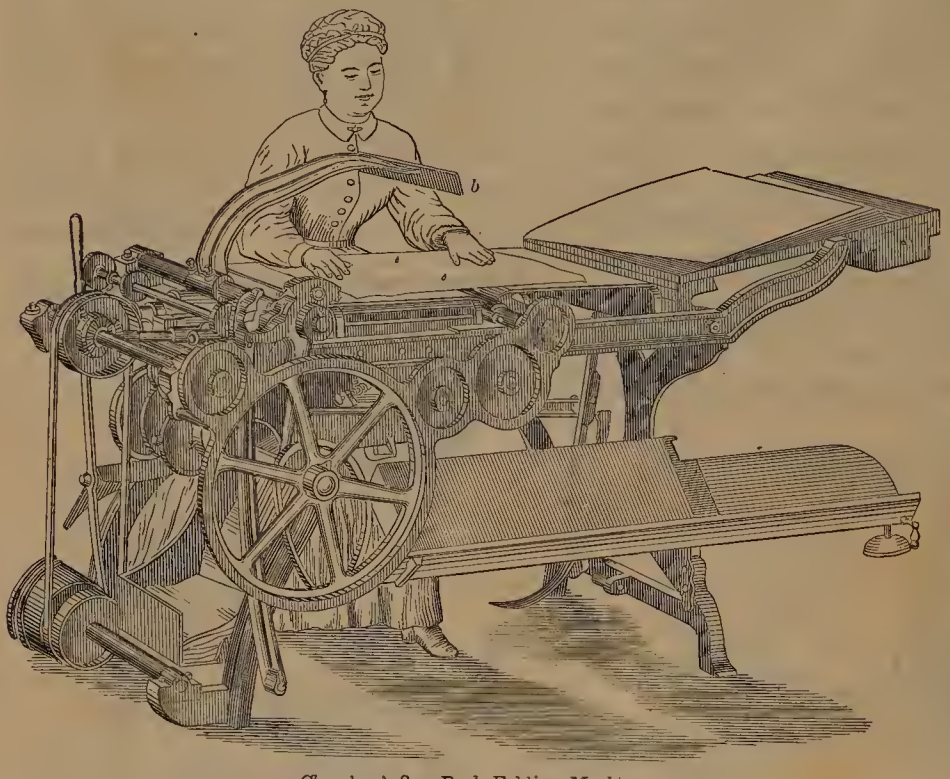
The book-folding machine illustrated is for octavo work, sixteen pages on a sheet, eight pages on a side. The sheet is placed on the table, so that two register-points pass through holes in the sheet previously made on the printing-press. The folder *b* comes down upon the folding edge, the pins give way, and the sheet passes, doubled-edge first, between a pair of rollers which compress it; tapes deliver it to a second table beneath, where a second and a third folder act upon it in turn, and it is delivered into a trough.

With 12mo work, imposed in two parts of sixteen and eight pages respectively, the machine cuts

them apart, folds the larger part like an octavo, the smaller folds but once, and is then *inset* into the octavo portion which forms the *outset*.

The two-sheet folder and paster, for large 24-page periodicals, folds one sheet of sixteen pages, $30\frac{1}{2} \times 45\frac{1}{2}$ inches, and another of eight pages, $22\frac{3}{4} \times 30\frac{1}{2}$ inches, insetting the eight pages within the sixteen, and pasting and trimming all, delivering a complete copy of twenty-four pages ready to read. It will fold eight pages alone, sixteen pages alone, with or without pasting, or trimming; or will fold, paste, and trim the sixteen pages, and fold, paste, and trim the eight pages, insetting same without pasting in the inset.

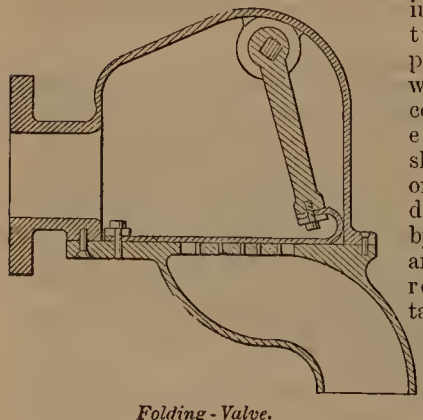
Fig. 2059.



Chambers's 8vo Book-Folding Machine.

Machines of this general character are also made for folding, pasting, and trimming; or for folding, pasting, trimming all round, and putting on a cover of different colored paper. Rev. H. W. Beecher's weekly journal, the "Christian Union," is folded, inset, and covered in this manner. This paper uses a single large sheet of 43 × 47 inches, making twenty-four pages, and, with the added cover, twenty-eight. The sheet is printed on a four-cylinder press, and, by an ingenious arrangement of rollers and tapes, fed mechanically from the impression-cylinders into four folding-machines, an attendant being at each machine to secure accurate pointing. This economy of time in feeding, etc., makes easily possible the printing, folding, pasting, trimming, and mailing (by Dick's system) of nearly 150,000 papers every week, within two and a half working days.

Fig. 2060.



Folding-Valve.

2. (*Metal.*) One which bends pans and tin-ware to form. Some are rollers, others presses, and yet others act like the envelope-machine, having hinged leaves which press up the sides against a former.

Fold'ing-net. A bird-net shuting upon its prey.

Fold'ing-valve. A flexible flap which lies upon the perforated plate forming its seat, and rolls or unrolls thereupon to open or close the passage-way. The band is connected to an arm on a shaft which passes through a stuffing-box to the outside of the case.

Fo'li-at'ed-arch. (*Architecture.*) One having a number of lobes or leaves. See ARCH.

Fo'li-at'ed-joint. (*Carpentry.*) A rabbeted joint, where one part overlies another.

Fo'lio. 1. The running number of the pages of a book. The *even* folios are on the left-hand pages, the *odd* upon the right. The folios of prefatory matter are frequently in lower-case Roman numerals.

2. A book whose sheets are folded but once, four pages to the sheet.

Fo'lio-post. A flat writing-paper, usually 17 × 24 inches.

Fol'low-board. (*Founding.*) A board beneath the pattern, and on which it lies while the loam is being rammed. See FLASK.

Fol'low-er. 1. A portion of a machine, usually sliding in guides, and moved by another portion; as the reciprocating punch-stock in a fly-press, which is moved by the screw to which it is swiveled. It is analogous to the platen of many presses.

2. The cover or *plug* of a stuffing-box, which rests upon and compresses the packing. A *gland*.

Fol'low-er-wheel. The *driven* wheel, as distinguished from the *driver*, or the wheel which impels.

Fon'dus. A style of calico-printing or paper-hanging in which the colors are in bands and blend into each other.

Font; Fount. (*Printing.*) An assortment of type of one size, of a given weight, containing large and small capitals, small letters, points, accents, figures, spaces, quads, etc. The weights of fonts vary according to the business requirements of the printer. While a 500-pound book-font was considered a good weight during the last century, some American houses

now keep a font of from 20,000 to 30,000 pounds in use.

The following table gives an English bill of Pica, weight 800 pounds, italic one tenth.

a,	8,500	í,	100	!	150	P,	400	I,	400
b,	1,600	ó,	100	’	700	Q,	180	J,	150
c,	3,000	ú,	100	*	100	R,	400	K,	150
d,	4,400	à,	200	†	100	S,	500	L,	250
e,	12,000	è,	100	‡	100	T,	650	M,	200
f,	2,500	ì,	100	⌈	150	U,	300	N,	200
g,	1,700	ò,	100	‖	100	V,	300	O,	200
h,	6,400	ù,	100	§	100	W,	400	P,	200
i,	8,000	â,	200	(	300	X,	180	Q,	90
j,	400	ê,	200	¶	60	Y,	300	R,	200
k,	800	î,	100	1,	1,300	Z,	80	S,	250
l,	4,000	ô,	100	2,	1,200	Æ,	40	T,	320
m,	3,000	û,	100	3,	1,100	Œ,	30	U,	150
n,	8,000	ä,	100	4,	1,000	A,	300	V,	150
o,	8,000	ë,	100	5,	1,000	B,	200	W,	200
p,	1,700	ï,	100	6,	1,000	C,	250	X,	90
q,	300	ö,	100	7,	1,000	D,	250	Y,	150
r,	6,200	ü,	100	8,	1,000	E,	300	Z,	40
s,	8,000	ā,	100	9,	1,000	F,	200	Æ,	20
t,	9,000	ē,	150	0,	1,300	G,	200	Œ,	15
u,	3,400	ī,	100	$	100	H,	200		
v,	1,200	ō,	100	A,	600				
w,	2,000	ū,	100	B,	400				
x,	400	ă	100	C,	500				
y,	2,000	ĕ	150	D,	500				
z,	200	ĭ	100	E,	600				
&,	200	ŏ	100	F,	400				
fi,	500	ŭ	100	G,	400				
ff,	400	ç,	100	H,	400				
fl,	200	ñ	100	I,	800				
ffl,	100	,	4,500	J,	300				
ffi,	150	;	800	K,	300				
æ,	100	:	600	L,	500				
œ,	60	.	2,000	M,	400				
á,	100	-	1,000	N,	400				
é,	250	?	200	O,	400				

Spaces.

Thick .	18,000
Middle .	12,000
Thin . .	8,000
Hair .	3,000
Em-quadrats	2,500
En-quadrats	5,000

Large Quadrats.

2-em, 3-em, 4-em } 80 pounds.

Metal Rules.

1-em, 2-em, 3-em.

For indexes and similar matter, the above would be deficient in capitals.

For setting up French or Italian matter, it would be deficient in accented vowels.

It comprises, —

Capitals ; as, A, B, etc.

Small capitals ; as, A, B, etc.

Lower case ; as a, b, etc.

Figures and fractions ; as, 1, 2, 3 ; $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{20}$, etc.

Points, — , ; : . ? ! - ’ ( ) [ ] * † ‡ § ‖ ¶ — ~~~

Spaces. Quads.

Accents ; as, á, à, â, ä, ā, ă.

The above bill does not include, —

Superior letters in caps or lower case ; as, A^A, B^D, etc. ; A^a, B^a, C^d, etc. ; a^A, b^C, etc. ; c^a, d^b, h^d, etc.

Inferior letters in caps or lower case ; as, A_C, C_B, etc. ; A_a, B_a, B_b, etc. ; a_B, c_E, etc. ; a_a, b_a, c_b, etc.

Superior figures in Arabic or Roman ; as B^1, C^2, D^3, etc. ; a^i, b^{ii}, c^{vi}, etc.

Inferior figures in Arabic or Roman ; as, A_1, B_2, C_3, etc. ; a_i, b_{iv}, c_v, etc.

Prime letters ; A′, B″, C‴ ; a′, b″, c‴, etc.

Arithmetical signs ; such as +, ×, −, ÷, :, ::, =, $\surd$.

Notation of arc : °(degrees), ′(minutes), ″(seconds).

Of quantity : ℔, ʒ, ℥, ℈, ♏.

Commercial : $, ¢, ℔, %, @, a/c, £.

Besides these, there are hundreds of arbitrary signs, which are found in the most perfect fonts, and used in astronomical, classic, commercial, musical, chemical, botanical, arithmetical, and mathematical dissertations.

For these, see an excellent digest on pp. 1692–96 of Webster's Unabridged Dictionary, edition of 1867.

Almost every science has symbols of its own. Algebra has one set, chemistry another. For a dictionary which attempts to represent the minute shades of pronunciation a great number are required. Thus in Webster or Worcester, what with letters with dots above and dots below, lines above, below, and across, there are probably a hundred additional characters. Some foreign languages have a very complicated alphabet. The Greek, with its "accents" and "breathings," requires about 200. Formerly there were so many logotypes and abbreviations as to require 750 sorts. The Oriental alphabets are complex. The Hebrew, with the Masoretic points, requires about 300 sorts, many differing only by a point, stroke, or angle. The Arabic has quite as many. In Robinson's Hebrew Lexicon, eight or ten Oriental languages appear, and required 3,000 sorts distributed through at least forty cases.

Fools'cap. A size of folded writing-paper named from the water-mark of a "foolscap and bell" which formerly ornamented (?) it.

In England, it has four grades of size and weight.

	Size.	Weight.
Sheet and a half foolscap,	$25\frac{1}{2} \times 13\frac{1}{4}$ inch.	22 pounds.
Sheet and third "	$22 \times 13\frac{1}{4}$ "	20 "
Extra thick "	$16\frac{1}{2} \times 13\frac{1}{4}$ "	18 "
Ordinary "	$16\frac{1}{2} \times 13\frac{1}{4}$ "	15 "

The American average may be stated at $16 \times 12\frac{1}{2}$.

Foot. 1. (*Music.*) The lower end of an organ-pipe, which conducts the wind to the *reed* or *lip*, which gives the vibration to the air and causes the sound.

2. (*Nautical.*) The lower edge of a sail.

3. (*Machine.*) A flange at the lower end of a leg to give a wider basis of support.

4. A third of a yard. See UNIT.

Foot, Ar'ti-fi'cial. A prosthetic contrivance which copies the articulations of the natural foot. In the best efforts in this line, the ankle-joint is a

Fig. 2061.

Artificial Foot.

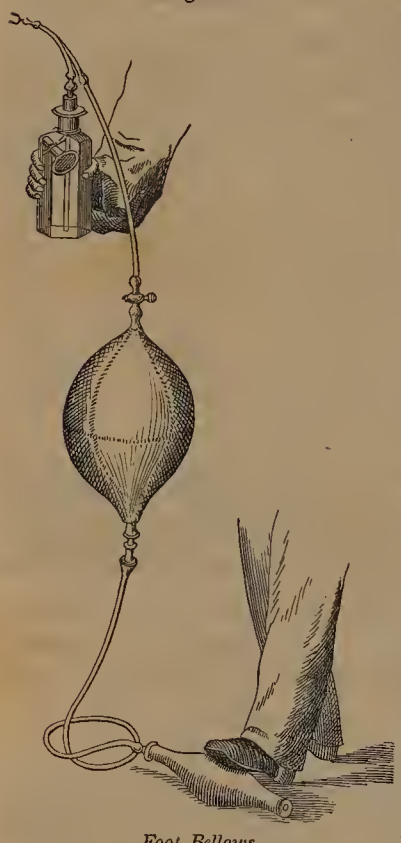
bolt which is transverse with the foot, a certain degree of lateral flexure in a vertical plane being also permitted, as seen by the interval shown in the left-hand figure opposite to *a*. The other figure also shows a certain liberty of forward and backward rocking motion. The middle rod *c* is a permanent tension-rod, and the rods *m n n′* have a certain amount of elasticity by means of rubber nuts, so as to allow flexure of the joint.

Foot-bel'lows. A form of bellows with a collapsible bag, or an ordinary bellows arranged to be worked by treadle. It is shown (Fig. 2062) as adapted to a spray apparatus.

Foot-board. 1. A treadle.

2. A board at the foot of a bed ; a board for the feet on the driving-box of a coach.

Fig. 2062.



Foot-Bellows

3. The platform on which the driver and stoker of a locomotive stand. A *foot-plate*.

Foot-bridge. 1. One for pedestrians over a railway or crowded city thoroughfare.

2. (*Machinery.*) A curved bar supporting the *foot* or *toe* of a mill spindle. See STEP.

Foot-guard. (*Menage.*) A boot or pad to prevent the cutting of the feet by interfering or overreaching. See LEG AND FOOT GUARD.

Foot-ham'mer. One worked by a treadle. The hammer is adjustably pivoted to the upright, and has toggle connection with the treadle, whose depression causes the descent of the hammer upon the anvil. The hammer is raised by a spring.

Fig. 2063.

Foot-Bridge.

Foot'ing. 1. (*Hydraulic Engineering.*) The lower portion of the slope of a sea embankment. It should have a base of five feet to one foot perpendicular and be protected by gravel. The portion above the footing is the *outburst bank*, and has a base of two to one perpendicular. The crowning portion is the *swash-bank*, which has a base of two to one perpendicular, the level on top being four or five feet. In Holland, where the summit is used for roads, this width is much increased.

2. (*Masonry.*) The spreading courses at the bottom of a wall, to give a greater basis of support.

Foot-i'ron. A carriage-step.

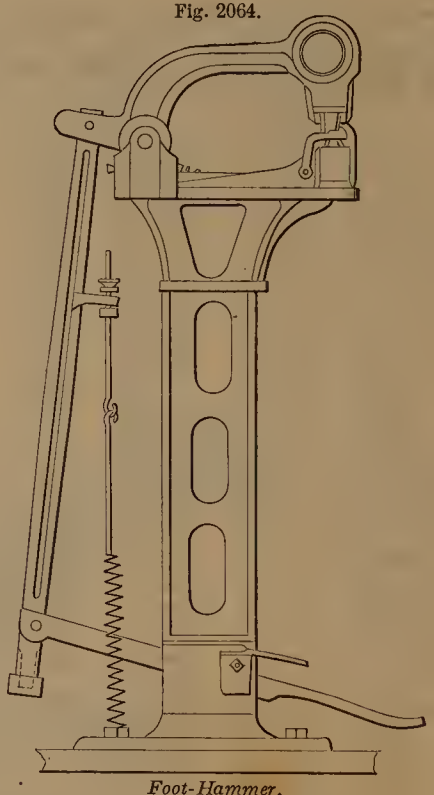
Foot-key. (*Music.*) An organ pedal.

Foot-lathe. A lathe driven by the foot on a treadle, connected to a crank on an axle beneath the bench. A driving-wheel on the axle is connected by a band to a cone-wheel on the mandrel of the head-stock.

Foot-lev'el. A form of level used by gunners in giving any proposed angle of elevation to a piece of ordnance. See LEVEL.

Foot-light. A light on the front of a stage.

Fig. 2064.



Foot-Hammer.

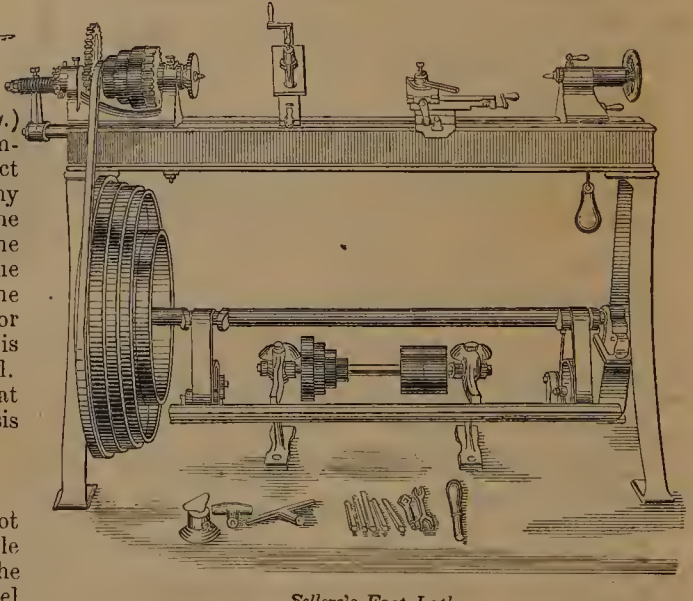
Foot-pace. A *dais*, or raised floor.

Foot-pad. (*Menage.*) *a.* A piece of elastic substance, say rubber, to cover the sole of a horse's foot and prevent balling.

b. An anklet or ridge-piece on the corona to prevent cutting of one foot by the other in traveling.

Foot-plate. The platform for the driver and fireman of a locomotive.

Fig. 2065.

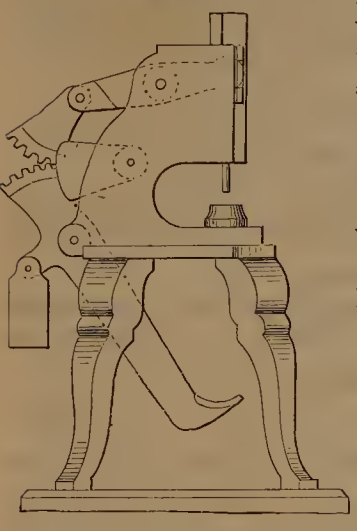


Sellers's Foot-Lathe.

Foot-pound. A term in mechanics; the unit of energy, 1 pound avoirdupois raised 1 foot. See UNIT.

Foot-press. A form of standing press in which the upper die or follower is depressed by a treadle.

Fig. 2066.



Foot-Press.

In the example, the motion is obtained by the meshing of two segmental cam-gears forming a toggle.

Foot-rail. A railroad-rail having wide-spreading foot flanges, a vertical web, and a bulb-shaped head. Such a rail may be spiked to the sleepers, dispensing with chairs.

Foot-rest. (*Menage.*) A stake in a shoeing shop on which a horse's foot is rested to relieve the shoer from the labor of supporting it.

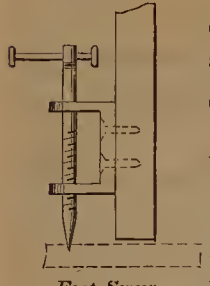
Foot-rope. (*Nautical.*) *a.* A rope stretched beneath a yard, upon which the seamen stand in reefing or furling sails.

b. A rope at the foot of a rail.

Foots. Sedimentary matter; the remainder or refuse of decantation or distillation.

Foot-screw. A supporting foot, for giving a machine or table a level standing on an uneven floor.

Fig. 2067.



Foot-Screw.

Foot-stalk. (*Machinery.*) The lower portion of a mill spindle; it rests in a *step*.

Foot-stall. 1. (*Architecture.*) The plinth or base of a pillar.

2. (*Menage.*) The stirrup of a woman's saddle.

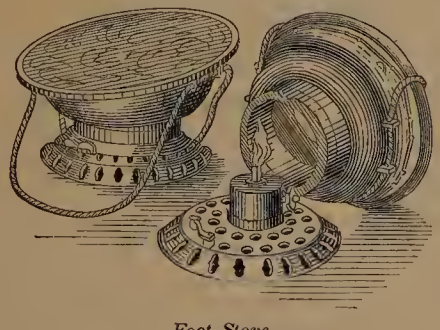
Foot-step. An inclined plane under a hand printing-press.

Foot-stick. (*Printing.*) A wedge-shaped piece of furniture placed against the foot of the page. The *quoins* are driven in between the *foot-stick* and the *chase* in locking up the *form*.

Foot'stool. A low stool for the feet.

Foot-stove. A foot-warmer; usually heated by a lamp.

Fig. 2068



Foot-Stove.

Foot-valve. (*Steam-engine.*) The lower valve between the air-pump and condenser. See AIR-PUMP, p. 53.

Foot-vise. A vise whose jaws are brought together by means of a strap passing through the two and operated by a treadle. It has not a very powerful grasp, but from the facility with which the jaws are opened or closed is useful in operating on objects which do not require to be held very firmly.

Foot-wal'ing. (*Shipbuilding.*) The inner *skin* of a ship between the *deck-beams* and the *limber-strakes* on each side of the *keelson*. Also called the *ceiling*.

Foot-warm'er. A heated stool for the feet. A chafing-dish. A *foot-stove*.

A hot-water bottle shaped to fit against the soles of the feet of a person lying in bed.

For'ceps. A tool applied to grasping, and consisting of two portions pivoted together, the ends forming respectively handles and jaws.

Shears, scissors, pincers, pliers, tongs, calipers, nippers, punches, and some other tools, agree in the pivoting of duplex parts, but they differ in some peculiarity of the jaws or in their special application for cutting or grasping. See JAW-TOOLS.

Forceps for teeth, uvula, arteries, esophagus, etc., were found in a house in Pompeii in 1819. They were of iron and copper.

Specifically: in obstetrics, an instrument having a pair of curved blades for grasping the head of the fetus and assisting delivery.

See under the following heads: —

Alveolar forceps.
Artery-forceps.
Bone-forceps.
Bullet-forceps.
Calculi-forceps.
Cow-horn forceps.
Crane's-bill.
Craniotomy-forceps.
Crow's-bill.
Dental forceps.
Dissecting-forceps.
Esophagus-forceps.
Eye-forceps.
Fulcrum-forceps.
Locking-forceps.
Needle-forceps.
Obstetrical-forceps.
Placenta-forceps.
Plugging-forceps.
Polypus-forceps.
Screw-forceps.
Speculum-forceps.
Spicula-forceps.
Stage-forceps.
Strabismus-forceps.
Trachea-forceps.
Uvula-forceps.

Force-pump. 1. A pump which delivers the water under pressure, so as to eject it forcibly or deliver it at an elevation. The term is used in contradistinction to a *lift-pump*, in which the water is lifted, and simply *runs* out of the spout.

The *single-acting* force-pump is that in which the *lift* and *delivery* are alternate. The *double-acting* is that in which the passages are duplicated, so that a *lift* and *delivery* are obtained by each motion of the plunger: the pump has a distinct water-way both above and below the piston, so as both to draw and force water at each stroke, and thus cause a continuous stream, which is rendered more uniform by an air-chamber.

The invention of the force-pump is ascribed to Ctesibus of Alexandria, who is assumed to have been the tutor of Hero, who wrote so largely on hydraulics. It was also described by Vitruvius.

In 1582, Peter Morice, a Dutchman, erected a pumping-engine at London Bridge, where it or its successors remained till 1821. The power was a current-wheel turned by the flow and ebb, and first placed *near* the bridge, then *under* the northern arch; afterwards three wheels were added under the third arch; Smeaton added another under the fifth arch, and afterwards a steam-engine to assist at low-water and neap tides. See CURRENT-WHEEL.

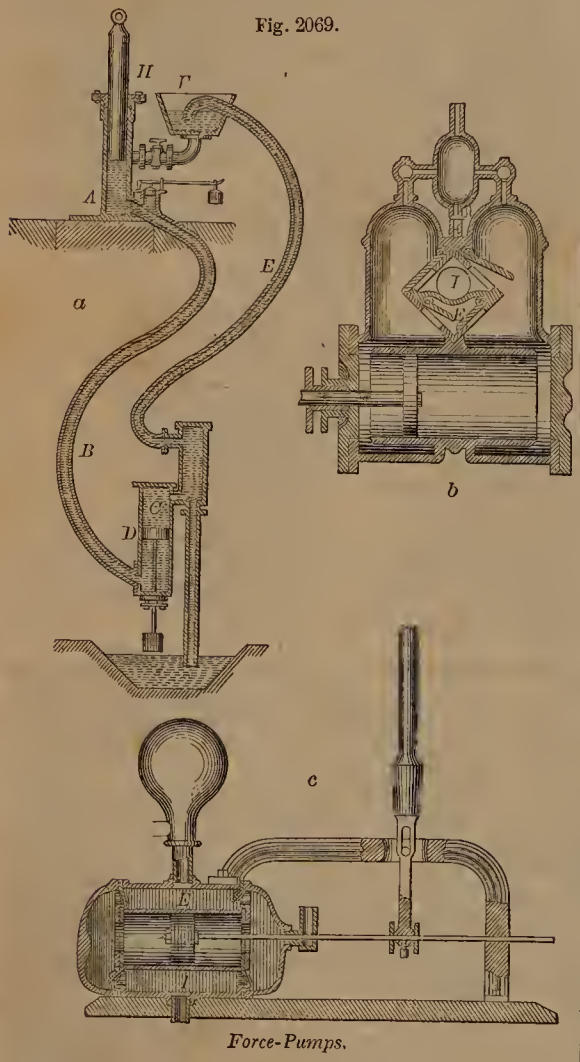
The water-wheel of Morice worked sixteen force-pumps, each seven inches in diameter, the pistons having a stroke of thirty inches, throwing 216 gallons per minute into a cistern elevated 120 feet, whence the dwellings in the vicinity were supplied with water by leaden pipes.

In 1731 the works are again described. Sixty-

eight pumps were then at work, throwing 2,052 gallons per minute. The cylinders were of cast-iron, 4 feet 9 inches long, 7 inches bore, and discharged by a stand-pipe into a cistern elevated 120 feet.

The Verpilleux pump (*a*) is a single-acting force-pump in which a column of water communicates between the working cylinder and the water level. When the plunger *H* rises, water ascends and passes through *C* into *B* and upward into *A* ; owing to the pressure of air upon the surface of the water in the cistern, supplemented for hights above, say 30 feet, by the weight of the loaded piston *D*. When the

Fig. 2069.



Force-Pumps.

plunger *H* descends, the column of water in *B* acts upon the piston *D*, and raises water in *E* to the reception cistern *F* above.

b c are two forms of double-acting force-pumps, in each of which *I* is the induction and *E* the eduction.

2. The boiler-supply pump connected to the piston-rod of the cylinder of a locomotive.

For'cer. A small pump worked by hand ; used in sinking pits, draining cellars, etc.

Forc'ing-pit. A sunken hot-bed.

Fore. (*Nautical.*) The term expressive of the forward portion of a vessel, or the appurtenances of the said forward portion. The term is used in contradistinction to *aft*.

Fore-and-aft Sail. (*Nautical.*) A sail whose middle position is fore-and-aft ; one which is attached to a spar or stay in the midship line of the vessel, and not to a yard, which is athwart ship.

It may be three-cornered, as a *stay-sail* or *jib*, or four-cornered, as a *try-sail*, *spanker*, etc.

Of the latter, —

The upper, after corner is the *peak*.

The upper, forward corner, the *throat* or *neck*.

The lower, after corner, the *clew*.

The lower, forward corner, the *tack*.

The *clew* is hauled aft by a rope called the *sheet*.

The *tack* is hauled forward by a rope also called the *tack*.

In a fore-and-aft sail,—

The *head* is the upper edge if the sail be four-cornered, or the upper corner if the sail be three-cornered.

The *foot* is the lower edge.

The foremost edge is called the *luff* or *weather-lecch*.

The aftermost edge is called the *lee-lecch*, or the *lecch*.

Schooners, smacks, and cutters are fore-and-aft rigged. The *spankers*, *drivers*, *jibs*, *try-sails*, and *stay-sails* of other vessels are also fore-and-aft.

Fore-bay. (*Hydraulics.*) A reservoir or conductor between a mill-race and a water-wheel. The discharging-end of a head or mill-race. The term is the equivalent of *penchute* or *penstock*, but is used especially in regard to water-wheels, which receive and discharge water at their peripheries, such as the under-shot, over-shot, breast, and flutter-wheels.

Fore-beam. (*Weaving.*) The breast-beam of a loom.

Fore-bow. (*Menage.*) The pommel or horn of a saddle.

Fore-car'riage. (*Vehicle.*) The forward part of the running gear of a four-wheeled vehicle. The fore-wheels, axle, and hounds ; with or without the *pole* and the *perch*.

Fore'cas-tle. (*Shipbuilding.*) *a.* In flush-decks ; a part of the upper deck forward of the after fore-shroud.

b. A short upper deck forward. Formerly raised like a castle to command the enemy's decks. A top-gallant forecastle.

c. A forward part of the space below decks in merchant-ships, for the seamen.

Fore-edge. The front edge of a book or a folded sheet ; in contradistinction to the *back*, which is folded, and holds the stitching.

Fore-foot. (*Shipbuilding.*) The forward end of a vessel's keel on which the stem-post is stepped.

Fore-gang'er. (*Nautical.*) A short rope grafted on to the harpoon, and to which the rope is bent.

Fore-ham'mer. A sledge-hammer, working alternately or in time with the hand-hammer.

Fore-hook. (*Shipbuilding.*) A strengthening piece in the stem, binding the bows together. A *breast-hook*.

Fo'rel. (*Bookbinding.*) A kind of parchment for book-covers.

Fore'land. 1. (*Hydraulic Engineering.*) That portion of the natural shore on the outside of the embankment which, standing several feet above low-water mark, and having a considerable breadth, acts as an advanced guard to the embankment to receive the shock of the waves and deaden their force upon the bank.

2. (*Fortification.*) A space between a fortified wall and the moat.

Fore-lock. A cutter or split pin in the slot of a bolt to prevent retraction. A *linch-pin*. A *pin* fastening the cap-square of a gun. A *key*.

Fore-lock Bolt. One retained by a *key*, *gib*, or

cotter passing through a slot of the shank. See KEY; COTTER.

Fore-lock Hook. (*Rope-making*) A winch or *whirl* in the *tackle-block* by which a bunch of three yarns is twisted into a *strand*.

Fore'mast. (*Nautical.*) The one nearest to the bow, in vessels carrying more than one mast, except in the case of a *ketch*, whose forward mast is the *main*, as being the longer of the two, the after-mast being the mizzen.

Fore-part I'ron. An edge rubber or burnisher for boot and shoe soles.

Fore-piece. (*Saddlery.*) The flap attached to the fore-part of a side-saddle, to guard the rider's dress.

Fore-plane. (*Joinery.*) Intermediate in length and application between a *jack*-plane and a *smoothing*-plane.

Fore-rake. (*Shipbuilding.*) So much of the forward part of a vessel as overhangs the keel.

Fore-run'ner. (*Nautical.*) A piece of red bunting on a log-line at a certain distance, say twelve or fifteen fathoms, from the log-chip; the fathoms begin to count at the fore-runner, and the non-counting portion is called the *stray-line*. The latter is an allowance to allow the log to be out of the ship's dead-water. See LOG.

Fore-shore. (*Hydraulic Engineering.*) *a*. A bank a little distance from a sea-wall to break the force of the surf.

b. The seaward projecting, slightly inclined portion of a breakwater.

Fore-shot. The first portion that comes over in distillation of low wines. It is a milky liquid and abounds in fusel oil.

Fore-sight. 1. A sight *forward* at the leveling-staff or through the sights of the circumferentor.

2. The muzzle-sight of a gun.

Fore-staff. (*Optics.*) An instrument formerly used at sea for taking the altitude of heavenly bodies, and also known as a *cross-staff*. The observer faces the object, the position being the reverse of that assumed in using the *back-staff* for a similar purpose. The fore-staff has a straight, square staff graduated like a line of tangents, and four *crosses* or vanes which slide thereon. The first and shortest of these vanes is called the *ten*-cross, and belongs to that side of the instrument whereon the divisions begin at 3° and end at 10°. The next longer vane, called the *thirty*-cross, belongs to the side of the staff graduated from 10° to 30°. The *sixty*-cross belongs to the side graduated from 20° to 60°. The *ninety*-cross belongs to the side of the staff graduated from 30° to 90°.

Fore-star'ling. An ice-breaker in advance of the *starling* of a bridge.

Fore-wale. (*Saddlery.*) The smaller roll of a horse-collar.

Forge. 1. A blacksmith's open fire, where iron is heated by the aid of a blast. The illustration shows a portable form, in which the bellows is worked by a treadle, the air-pipe passing upward and through a tuyere into the coal-box *a*, which is shown empty. *b* is the slake-trough.

2. A building in which blacksmith's forges or furnaces are arranged. When on a large scale, furnaces, cranes, and steam-hammers are necessary adjuncts. A *smithy*.

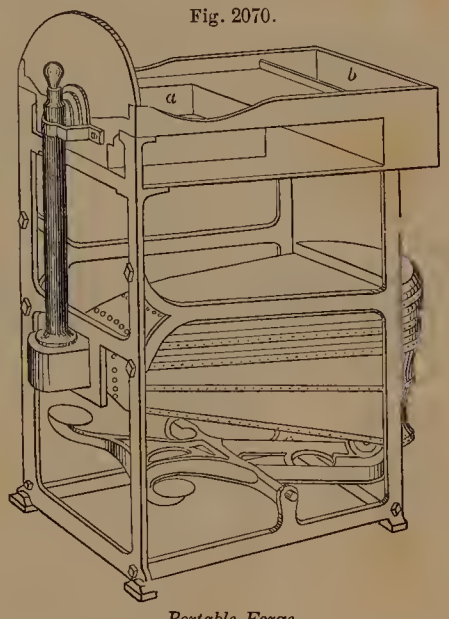
3. A place where iron is puddled and shingled.

4. A field-forge in military service. See BATTERY-FORGE.

The subject of *forging* is incidentally considered under CANNON, ARMOR-PLATING, and elsewhere, and the appliances under ANVIL, HAMMER, etc. See HAMMER; also list under BLACKSMITH'S TOOLS, etc.

Considering how lately it has been deemed possible to forge very large masses of iron, and how all

Fig. 2070.



Portable Forge.

the best modern appliances of furnaces, cranes, and steam-hammers are engaged in the production of heavy cannon, screw and paddle shafts of steamships, anchors, etc., we may well be surprised at the existence within the cincture of the ancient Mosque of the Kutub, near Delhi, of a wrought-iron pillar of a size which would be deemed a first-class forging in the most capable works of Europe or America. The pillar is, however, more than 1,000 years old, and may be as much as 1,500. It is believed that the ornamental capital was chipped from the solid. Digging has shown that the greater portion of the length is buried in the ground. It has about midlength an inscription in Sanscrit, in a character which has been assigned to the period A. D. 300 to 400. It has been described at length by Mallet in the "Engineer." The present writer concludes that it is a casting from iron smelted by a process allied to the Catalan, — the ordinary smelting process of Asia and Africa, in fact, — from a magnetic or hematite ore by charcoal. Such an iron may be worked to some extent by the hammer.

Fig. 2071.

Iron Pillar of Delhi.

The iron pillar of Delhi has the following dimensions: —

Hight above ground	22 feet.
Depth beneath ground, so far as is known by digging	26 "
Estimated hight	60 "
Hight of capital	3½ "
Upper diameter of shaft	12.05 inch.
Lower diameter of shaft	16.4 "
Weight (calculated)	38,080 lbs.

Forge-rolls. The name conferred upon the train of rolls by which the slab or bloom is converted into puddled bars.

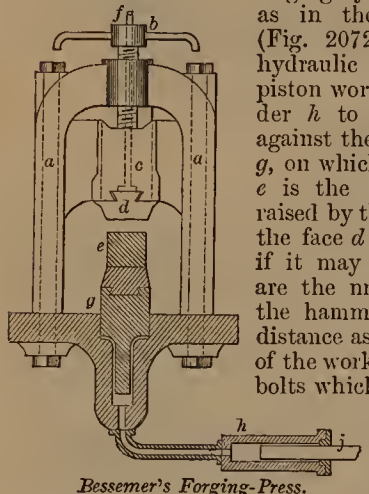
They consist of two pairs, the *roughing-down* rolls and *finishing* rolls.

For'gette. (*Glove-making.*) Fr., *fourgette.* The piece put between the fingers of a glove, and to which the front and back parts of the fingers are sewed.

Forg'ing-ham'mer. A hammer used by gold-beaters. It weighs three pounds, has a head at one end and a wedge at the other, the face having a square area of 1½ inches on the side. Its handle is 6 inches long. It is the first hammer in the series, and reduces the ingot of gold to one sixth of an inch. The anvil is a mass of steel four inches long and three broad. The *laminating-machine* is often used instead of the *forging-hammer.*

Forg'ing-ma-chine'. A machine having a number of plunging mandrels and stakes between which a heated bar is pressed to form. The opposing faces of the plungers and stakes may be merely hammer-faced, or may be shaped to act as swages.

Fig. 2072.



Bessemer's Forging-Press.

Forg'ing-press. One for forging by means of pressure, as in the Bessemer press (Fig. 2072), which acts by hydraulic pressure. *j* is a piston working in the cylinder *h* to drive the water against the base of the piston *g*, on which is the anvil face. *e* is the forging which is raised by the piston *g* against the face *d* of the hammer *c*, if it may be so called; *f b* are the means for lowering the hammer *e d* to such a distance as may suit the size of the work. *a a* are through-bolts which sustain the pressure.

Fork. An implement with prongs for lifting, digging, carrying, or throwing. Its uses may be principally included under the heads of *agricultural* and *husbandry* uses and *domestic* uses.

Of the former are: —

Dung or *manure* forks.
Horse hay-forks.
Digging-forks.
Grain-forks.
Hay-forks.
Pitch-forks.

Of the domestic are: —

Culinary or *flesh* forks. *Table*-forks.

1. The fork of the husbandman is shown on the Egyptian tombs, and referred to in the Book of Judges, 1093 B. C.: "Yet they had a file for the mattocks, and for the colters, and for the forks."

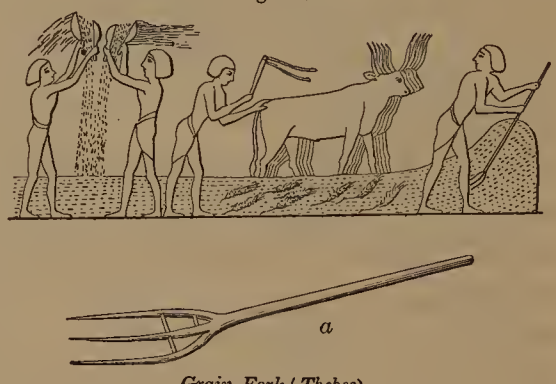
The pitch-fork is used for grain in the straw or sheaf, hay, and manure. It has from two to four teeth, according to its purpose. The four-pronged is used for manure, the others for straw, sheaves, or hay.

Another form of grain-fork (*a*) is of wood, the operative end being slit into three prongs, which are held apart by wedges and braced by rods.

It is used in delivering the gavel of grain from the platform of the reaping-machine, and is preferred for the reason that its tines do not injure the platform, or offer so much danger to the person or the machine as do sharp iron tines.

In the scenes where the thrashing of grain is represented on the tombs of Egypt, we see several instances of the three-pronged fork. It appears to be of wood, the end split into three tines, which are

Fig. 2073.



Grain-Fork (Thebes).

held apart in some way, perhaps, as with us, by wedges.

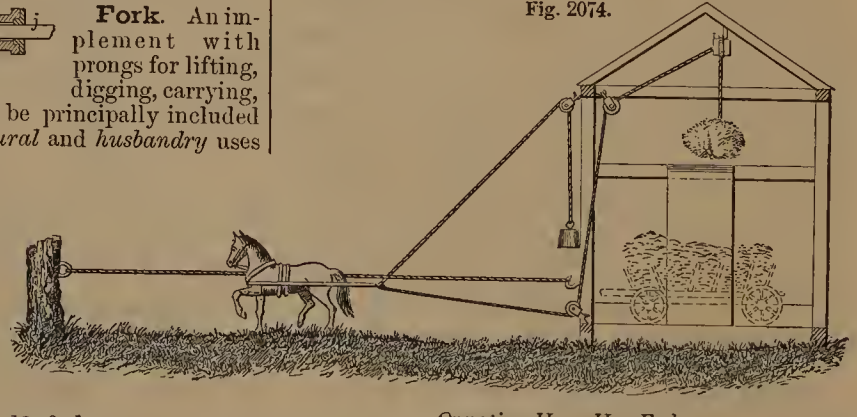
The digging-fork has four flat steel tines, and is a very effective tool.

The pitch-fork has two or three long, round tines, and is used for pitching hay or sheaves. The barley-fork is a peculiar fork having a guard on the head, and used for pitching gavels of short grain without binding.

The horse hay-fork is designed to obviate the great labor of pitching hay from the wagon into the mow, or from the wagon or the ground into the stack. They are of four kinds: —

1. The *harpoon*-fork.
2. The *jointed*-fork.

Fig. 2074.



Operating Horse Hay-Forks.

3. The *tongs*-fork.
4. The *corkscrew*-fork.

Fig. 2074 gives a general idea of the mode of operating the fork. A rope passes from the single-tree of the horse over three pulleys to the fork, which is thrust into the load. When the horse starts up, the load is lifted, and when it has reached the desired hight a trigger is pulled and the load dropped. The horse is backed, allowing the fork to descend, assisted by the weight which takes up the slack of the fall.

1. The *harpoon-fork* is thrust endwise into the hay, the tines being sheathed; then, by the motion of a lever, the tine or tines are exposed so as to catch the hay and elevate it when the fork is lifted. On reaching the place where the forkful is to be deposited, the catch which holds the tines in their ex-

tended position is dropped by drawing on a trigger; the tines becoming sheathed by the pressure upon them of the hay, the latter slips off. Two forms of this are shown, but twenty-eight are before the writer while making this notice. Fig. 2075 has a tube from which protrude two prongs *F F*, which are thrust out into the hay after the stem has been driven in to the required depth. When lifted, the load rests on the prongs, and when a trigger on the stem is pulled by the cord *g*, the prongs retreat; the tube falls until it catches on the cross-piece of the stem *D*. In Fig. 2076 the parts *E* and *F* form the entering portion and maintain a general longitudinal direction while the fork is thrust into the hay, and are vibrated outwardly to hold the hay by the pivoted rod, which is actuated by a lever and auxiliary rope, to drop the load when it has arrived over the desired spot.

2. The *single-jointed* fork is one in which the tines are hinged to the stock, so as to assume a position in which the hay will be sustained, but capable of being dropped from this position so as to allow the hay to slip off. The *modus operandi* is this:

Fig. 2075.

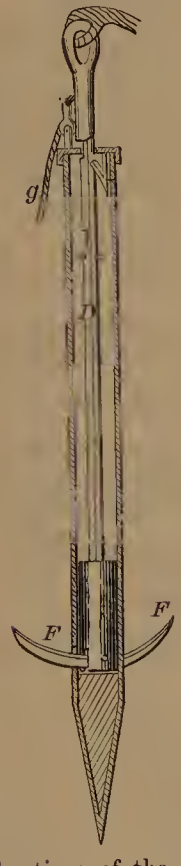
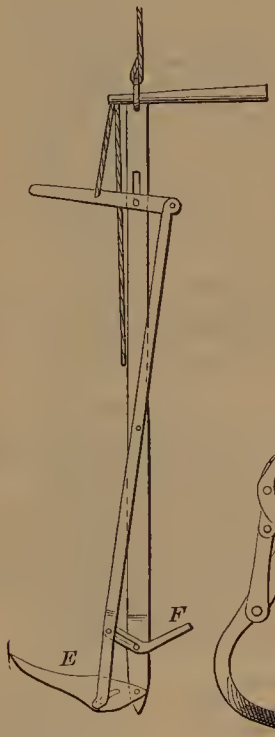


Fig. 2076.



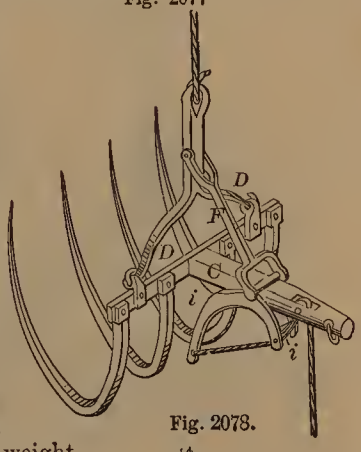
Harpoon-Forks.

The tines of the fork in its effective position are thrust into the hay, and the fork with its load is then elevated. On reaching the place where the load is to be deposited, a trigger is pulled, releasing the tines; the weight of the hay causes them to drop, and the load slips off.

Of fifteen kinds at hand, two may be selected as representative. In Fig. 2077, the tines are on a head attached to the stock *C* and hinged to the bail *D*. *F* is a hinged brace, which thrusts against a stud in a slot of the stock *C*, to hold the tines in their holding position. The tines are tripped by the rope and trigger *i*, which pushes the brace *F* off the detent and allows the head and stock to rotate on the bail.

Fig. 2078 has its tines *a* hinged at midlength, and tripped by lifting the trigger *e* on the end of the rope *f*.

Fig. 2077



3. The *tongs*, or *grabbing-fork*, has two hands, so to speak, which clasp upon the bunch of hay, and are locked in their closed position while the hay is being lifted. When arrived at the place to drop the hay, a rope attached to a trigger is pulled, the two heads of the fork are unlocked, and the weight of the hay presses them open, the hay falling out. The two forms shown are held closed by a straight toggle, and opened when the toggle is bent by a pull on the rope. In Fig. 2079 the fork is swung from one prong, and in Fig. 2080 from both prongs.

Fig. 2078.

Jointed Forks.

4. The *corkscrew-fork* is screwed down into the hay, turning in its handle or stock; a latch holds it in position while the hay is lifted. A trigger then releases the catch, and the tine being freed is rotated by the weight of the hay which slips therefrom.

Fig. 2079.

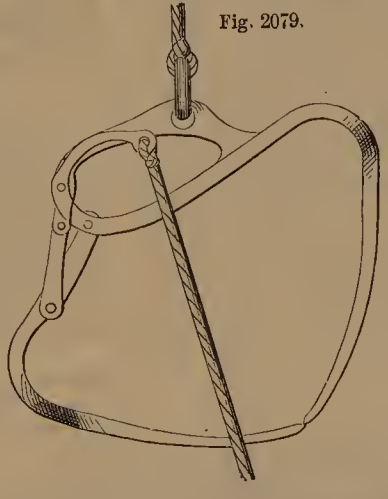
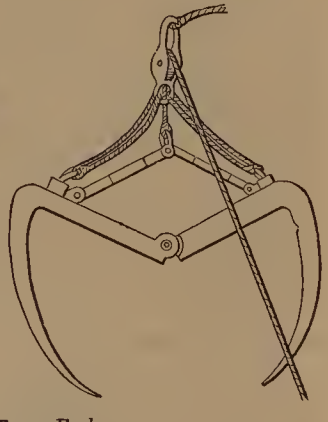


Fig 2080.



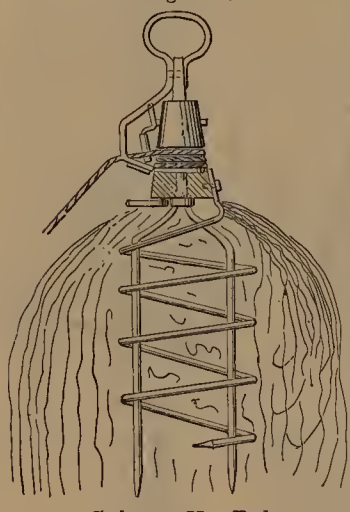
Tongs-Forks.

As the vertical tines descend into the bunch of hay, the spiral tines are rotated and then locked. The load being elevated, the cord is pulled, disengaging the detent and revolving the spiral tines to discharge the load.

2. Forks for culinary purposes were common in ancient times, *vide* the observances of the Hebrew priests, who dipped their forks into the seething-pot and lifted the meat thence. The table-fork is a modern invention, deriving its name from the Italian *forca*.

The Greeks and Romans had also flesh-forks or rakes to lift meat from the pot, but they had no table-forks. The carver, *carptor*, had a knife for carving, and the guests furnished their own. The meat was grasped by the finger and thumb of the

Fig. 2081.



Corkscrew Hay-Fork.

left hand, and a piece excised. The New Testament, Homer, and Ovid mention the putting of the hands in the dish.

The "dipping in the dish" refers to making a scoop of a piece of bread and dipping out the soup or gravy. To give a "sop" thus prepared to a friend at table was a delicate attention. Judas received his and "went out." The mark of kindness was too much even for his selfish heart.

The Chinese use chop-sticks instead of forks.

Bronze forks were used by the Egyptian priests in presenting offerings to the gods. Two of them exhumed at Sakkarah are in the Abbott collection.

A fork is mentioned in the accounts of Edward I., and is supposed to have been brought from the East by a returning crusader. Voltaire says that they were used by the Lombards in the fourteenth century; and Martius states that they were common in Italy in the fifteenth century.

Table-forks are heard of in Italy from 1458 to 1490. An Italian at the court of Matthias Corvinas, king of Hungary, notices the lack of the fork in the table furniture of the king. A century after, they were not known in France or Sweden.

Coryat, in his "Crudities," 1611, says: "I observed a custom in all those Italian cities and towns through which I passed, that is not vsed in any other country that I saw in my traules, neither doe I think that any other nation in Christendome doth vse it, but only Italy. The Italians and also most strangers that are commorant in Italy, doe alwaies at their meales vse a little fork when they cut their meat."

Fyne Moryson's "Itinerary," in the reign of Elizabeth, refers to their use in Venice.

Heylin in his "Cosmograph," 1662, says: "The use of silver forks, which is by some of our spruce gallants taken up of late, came from China into Italy, and thence into England."

Table-forks have long been in use in Feejee. At a time when all Northern Europe was destitute of the article, these remarkable savages, the most cruel and ingenious of all the natives of Polynesia, used forks in conveying to their mouths morsels of *puaka-balava*, long-pig, as they called cooked man.

Table-forks of the best quality are forged from the end of a rod of cast-steel, about three eighths square. The tang, shoulder, and shank are roughly formed and cut off, the prongs being a flat portion which is stamped out by a swage drop. The film between the tines is cleaned away by the file. These processes are followed by hardening, tempering, grinding, and hafting.

Fork-beam. (*Shipbuilding.*) A half-beam to support a deck where hatchways occur.

Fork-chuck. (*Turning.*) A piece of steel projecting from the live spindle and carrying the front center and a pair of joints which enter the wood and rotate it.

Fork-head. The double head of a rod which divides in order to form a connection by means of a pin.

Fork'staff-plane. (*Joinery.*) A joiner's plane for working convex cylindrical surfaces.

Fork-wrench. A spanner with two jaws which embrace a nut or a square on a coupling.

Form. 1. (*Printing.*) *a.* A body of type, composed and made ready for printing.

b. A stereotype in the like condition of readiness.

The one containing the first page is the *outer form*. The *form* for the opposite side of the sheet is the *inner form*.

2. A shape or mold for metal, glass, or jelly.

Form'er. A shape around which an article is molded, woven, wrapped, pasted, or otherwise constructed.

A templet, pattern, or gage by which an article is shaped, as pottery, or an object in the lathe.

A cutter by which patterns, blanks, wads, or pieces are cut from sheets for various purposes.

Form'ing. (*Shipbuilding.*) Shaping exactly the converted (partially shaped) timbers, so as to give them the required figure. This consists in: —

Siding; giving them the correct breadth.

Molding; giving the correct outline and depth.

Beveling; giving the faying surface the proper shape to meet the planking or iron skin.

Form'ing-cyl'in-der. (*Paper.*) That cylinder in a paper-making machine on which the film of pulp is gathered, and which delivers it as a soft and weak web to the hardening and drying devices.

For'ril. Lambskin parchment. Vellum.

Fort. A small fortification.

The *orthography* of a fort is its profile.

The *ichnography* is its ground plan. See FORTIFICATION.

Fort'al-ice. An outwork of a fortification.

For'ties. (*Printing.*) A sheet of paper having forty printed pages on each side. 40's.

For'ti-fi-ca'tion. Fortifications are known as, —

Natural, when cliffs, swamps, rivers, etc., conduce to give the advantage to the defending force.

Artificial, when labor and skill create advantages or add to the natural ones.

Defensive, when opposed to an attacking force.

Offensive, in investing a place.

Permanent, of a lasting character.

Field, for emergency or temporary uses.

There is no room here for a treatise; see details under the following heads: —

Abattis.
Ante-mural.
Approach.
Arrow.
Augette.
Avant-fosse.
Banquette.
Barbacan.
Barbette.
Barrier.
Bartizan.
Base.
Basket-work.
Bastion.
Bastioned fort.
Batardeau.
Battery.
Bavins.
Berme.
Blind.
Blindage.
Block-house.
Body of a place.
Bomb-proof.
Bonnet.
Bonnet de prêtre.
Boom.
Branch.
Bray.
Break.
Breast-hight.
Breast-work.
Bridge-head.
Brisure.
Bulwark.
Buttress.
Caltrop.
Camouflet.
Canditeer.
Capital.
Caponniere.
Casemate.
Cavalier.
Cavin.

Chamber.
Chemin des rondes.
Cheval de frise.
Circumvallation.
Citadel.
Coffer.
Coffin.
Contour.
Contravallation.
Cordon.
Corridor.
Counterguard.
Countermine.
Counterscarp.
Counter swallow-tail.
Counter-trench.
Countervallation.
Counter-works.
Coupurus.
Covered way.
Cremaillere.
Crenette.
Crest.
Crotchet.
Crown-work.
Crow's-feet.
Cunette.
Curtain.
Dead-angle.
Deblai.
Demi-bastion.
Demi-lune.
Demi-revetment.
Detached works.
Ditch.
Écoute.
Elevated battery.
Embrasure.
Enciente.
Envelope.
Epaule.
Epaulement.
Escarp.
Esplanade.
Estacade.
Exterior slope.
Face.
Fascine.
Fausse-braye.
Field-work.
Flank.
Fleche.
Fort.
Fortalice.
Fortress.
Fosse.
Fougasse.
Fraise.
Front.
Gabion.
Gallery.
Glacis.
Gorge.
Half-moon.
Half-sunken battery.
Herrison.
Herse.
Hersillon.
Horn-work.
Hurdle.
Hurter.
Indented line.
Indented parapet.
Interior slope.
Intrenchment.
Iron fortification.
Klicket.
Line.
Liziere.
Lodgment.
Loop-hole.
Lunette.
Magazine.
Magistral.
Mantlet.
Martello tower.
Masked battery.
Merlon.
Mine.
Moat.
Moineau.
Orgues.
Orillon.
Outwork.
Palisade.
Parados.
Parallel.
Parapet.
Picket.
Place of arms.
Plane.
Platform.
Plongée.
Portcullis.
Postern.
Priests' cap.
Profile.
Ramp.
Rampart.
Ravelin.
Redan.
Redoubt.
Re-entering-angle.
Relief.
Remblai.
Retired flank.
Retrenchment.
Revetment.
Revolving-tower.
Ridge.
Rifle-pit.
Rimer.
Salient-angle.
Sally-port.
Sand-bag.
Sap.
Sap-roller.
Saucisse.
Scarp.
Shoulder.
Sill.
Sillon.
Slope.
Sole.
Spur.
Star-fort.
Stockade.
Sunken battery.
Superior slope.
Swallow-tail.
Tenailles.
Tenaillon.
Terre-plein.
Tete de pont.
Tower.
Trace.
Traverse.
Traversing-platform.
Trench.
Trench-cart.
Trench cavalier.
Trous de loup.
Turret.
Van-fosse.
Zigzag.

For'tress. A large permanent fortification, such as, on our continent, Fortress Monroe, Quebec, St. Juan de Ulloa, Moro Castle. They are too numerous in Europe to be thus summarily cited.

For'ty-eightmo. (*Printing.*) A book made up of sheets printed 48 pages on a side. 48mo.

For'ward-fire Car'tridge. One in which the fulminate is at or in the base of the ball, forward of the powder. It is exploded by a stem *d*, as in the figure, or else by a needle which penetrates the whole extent of the powder, and strikes the fulminate in the base of the bullet. See NEEDLE-GUN.

Fig. 2082.

Forward-Fire Cartridge.

For'ward-ing. (*Bookbinding.*) That department which concerns the operation of plain covering a sewed book, ready for the finisher.

Fosse. (*Fortification.*) A moat or ditch around a fortification.

An *advance fosse* is a ditch encircling the glacis or esplanade of a fortification.

Foth'er-ing. (*Nautical.*) A mode of stopping a leak at sea by thrumming a sail with oakum and yarn and drawing it under the bottom so as to clog the aperture.

Fou'cault's Pen'du-lum. A pendulum for rendering visible the diurnal motion of the earth.

It consists of a *bob* suspended from a considerable hight, say the apex of the dome of the Pantheon or Capitol, and set to vibrating above a circular table marked with degrees. Owing to certain independence of motion which the *bob* possesses, vibrating in space, as it were, the earth in its diurnal motion turns round beneath it, as is evidenced by the *apparent* change of direction of the *bob* relatively to the graduated table. See PENDULUM.

Fou-gasse'. (*Fortification.*) A small mine, consisting of a hole charged with combustibles and projectiles hidden by earth, and placed in a position liable to fall into the hands of the enemy.

Fou-lard'. (*Fabric.*) A thin silk or silk-and-cotton dress-stuff.

Found. 1. A three square, *single-cut* file or *float*, with one very acute angle, used by comb-makers. See COMB.

2. To cast; as metal.

Foun-da'tion. 1. The bed or basis of a structure.

2. (*Hat-making.*) The body of a hat, of wool or inferior fur, upon which the napping of superior fur is laid and united at the *battery*.

Foun-da'tion-bolt. One which keeps a bed-plate — of an engine, for instance — down to its substructure.

Foun-da'tion-muslin. (*Fabric.*) An open-worked, gummed fabric, used for stiffening dresses and bonnets.

Foun-da'tion-pile. (*Hydraulic Engineering.*) One driven into soft or treacherous ground to form — with others — an unyielding basis for a structure.

Foun-da'tion-plate. 1. (*Bookbinding.*) The base plate on which ornaments are arranged in the stamping or embossing press.

2. (*Steam Engineering.*) The bed-plate of a steam-engine.

Found'er's Cleans'ing-mill. A *tumbling-box* in which small castings are cleansed from adhering

sand. In a similar box articles may be polished or rounded by mutual attrition, assisted, if need be, by an abradant, such as sand or emery.

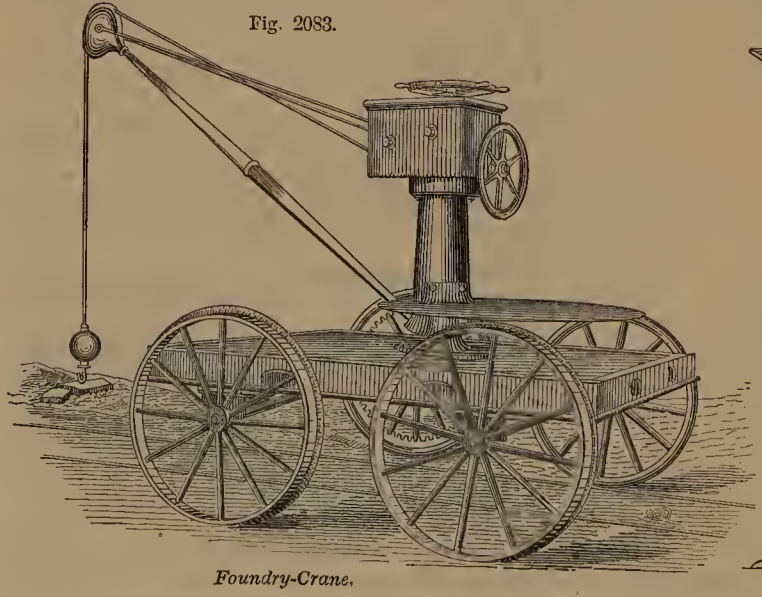
Found'er's-lathe. A lathe used in preparing the cores for loam-molding, such as those for iron pipes. A central spindle, being prepared, is placed on centers or on V's, and the clay loam covering is plastered on and regulated by a templet or pattern.

Found'ing. The art of casting metals. See under the following heads : —

Blackening.
Casting-box.
Casting-ladle.
Chamber.
Cheek.
Chill.
Chipping-piece.
Cleaner.
Cliché.
Compression-casting.
Contraction-rule.
Core.
Core-bar.
Core-box.
Core-print.
Crucible-tongs.
Dead-head.
Dryer.
Facing.
False core.
Flask.
Flask-clamp.
Follow-board.
Founder's lathe.
Gagger.
Gate. Geat.
Gland.
Grunter.
Hollow board.
Ingate.
Ladle.
Lingot.
Loam.
Loam-cake.
Mantle.
Match-plate.
Matrix.
Mold.
Molder's clamp.
Molder's flask.
Molder's table.
Mold-facing.
Molding and casting apparatus.
Molding-board.
Nowell.
Parting.
Perier.
Pickle.
Pig.
Plasm.
Rammer.
Runner.
Sand.
Shank.
Shuttle.
Slicker.
Sow.
Spill-trough.
Spray.
Sprue.
Stalk.
Statuary-casting.
Steady-pin.
Stopping-off.
Strickle.
Strike.
Sullage.
Tamping-bar.
Tedge.
Tile.
Trowel.
Tumbler.
Tumbling-box.
Undercut.

Foun'dry-crane. One used to lift and transport molds, flasks, castings, etc., in a foundry. Also known as a molding-crane, from its being used for lifting into and out of position the drags of molds, cores, and what not, in heavy casting, loam-work, and pit-casting. See CRANE.

Fig. 2083.



Foundry-Crane.

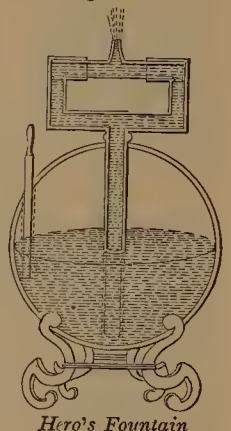
Fount. An assortment of printer's type. See FONT.

Foun'tain. 1. An upward jet of water, natural or artificial. With the latter we have alone to do.

Many ingenious pneumatic and hydraulic devices are shown in "Spiritalia Heronis," 150 B. C. Some were toys merely, and some, probably, were a part of the illusive machinery of the temples.

In the fountain of Hero, the motion of a column of water is transmitted to another by the intervention of a body of air between the two. The pressure of the elevated body of water compresses the air in a lower chamber ; the pressure is transmitted to the air in a chamber above, the water of which is ejected in a jet.

Fig. 2084.



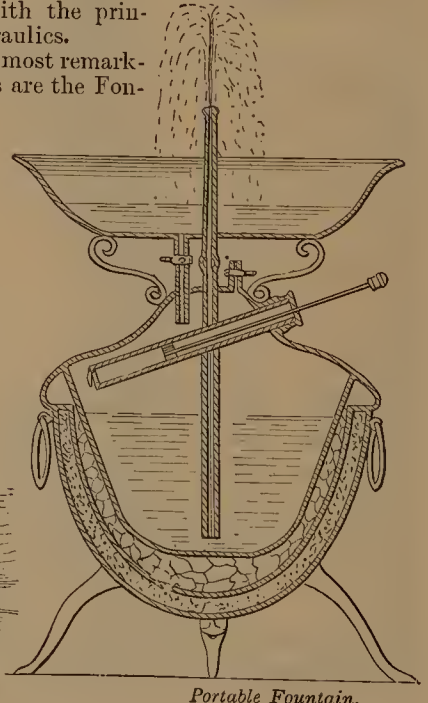
Hero's Fountain (150 B. C.).

The principle has been made use of in emptying the water from the mines of Schemnitz, Hungary. (See Fig. 58.)

Hero has anticipated by 2,000 years some of the modern parlor fountains, in which a body of compressed air above the water in the reservoir below is made the means of driving a jet of water into the air. An adjustment in two planes is given to the nozzle, so as to direct the stream in the required direction.

This contrivance, which appears simple enough when exhibited in section, was one of the hydraulic marvels of the pagan priests. Fig. 2085 is a late form, which has an ice-chamber and non-conducting casing. The gardens of Montezuma were adorned and nourished by streams and fountains. For the former they were indebted to extensive aqueducts. The possession of the latter shows that they were acquainted with the principles of hydraulics.

Fig 2085.



Portable Fountain.

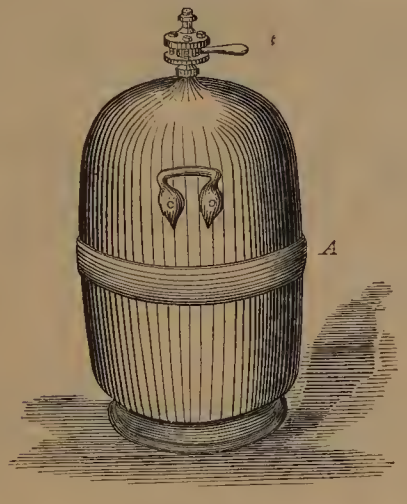
Among the most remarkable fountains are the Fon-

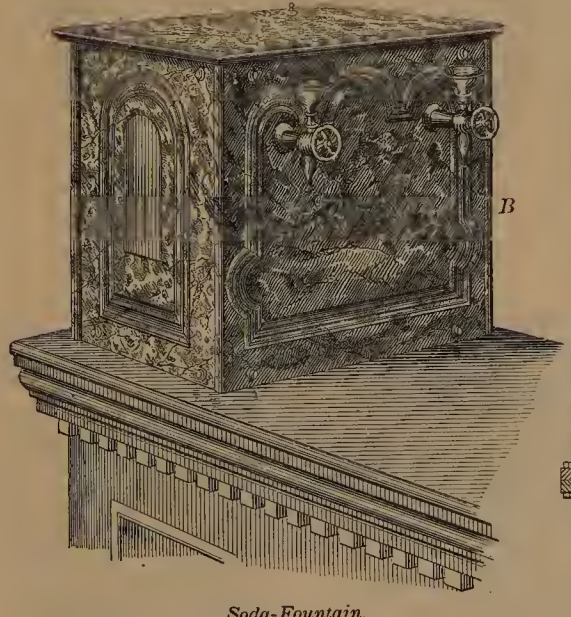
tana di Trevi at Rome, constructed for Pope Clement XII. in 1735; the Fontana Paolina, erected for Pope Paul V. in 1612; the Fontana dell' Aequa Feliee, or Fountain of Moses. The fountains of Versailles, made for Louis XIV., and the Jet d'Eau of St. Cloud, are much admired. The fountains of Chatsworth, in Derbyshire, England, the residenee of the Duke of Devonshire, are partieularly grand; as are also those of the Crystal Palace at Sydenham, near London. Cincinnati is also proud of a fountain made in Germany, and of a very Teutonic aspeet.

2. The "beer fountain," as it is called, used for drawing liquors in a tavern bar from barrels in the cellar, by means of a foree-pump, is the invention of Bramah, and was patented by him.

3. A eopper vessel *A* (Fig. 2086) containing aërated water for a beverage. It is used in eonnection with

Fig. 2086.





Soda-Fountain.

an ornate counter arrangement through which the liquid is drawn into tumblers. They are lined with block-tin to prevent corrosion of copper.

4. A box *B* eontaining ice and a eoil through which aërated water, known as "soda-water," is conducted to the nozzle, when it is drawn into glasses.

The sirup fountain is for the supply of the sirup whieh flavors the "soda," so called.

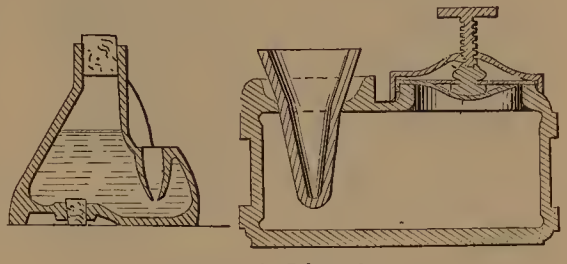
5. An upper reservoir chamber to eontain a liquid and supply a wiek, a dip-hole, a trough, ete. As in the oil-chamber of an Argand lamp, the reservoir of an inkstand, a drinking-glass in a bird-cage, etc.

6. The ink-reservoir in a printing-press.

7. The supply-ehamber in a reservoir pen.

Foun'tain Ink'stand. One whieh has a continual supply of ink from an elevated fountain (see Fig. 2087), or whieh has an elastic diaphragm by which the dip-cup may be supplied or emptied, as in Fig. 2088.

Fig. 2087. Fig. 2088.



Fountain-Inkstands.

Foun'tain-lamp. One with an elevated reservoir for supply, as in most forms of the Argand, — the student's lamp, for instance.

Gerard used an air-pump to force oil from a low chamber to the burner of an Argand lamp, so as to avoid throwing a shadow upon surrounding objects.

Foun'tain-pen. One which has an ink reservoir for the supply of the pen.

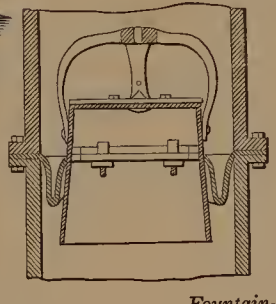
Fig. 2089.

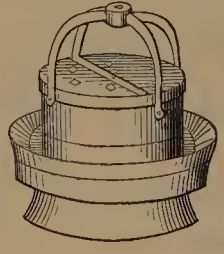
Seheffer's fountain-pen, introdueed in England about 1835, had a reservoir of ink in the holder, and the ink is admitted to the pen by the pressure of the thumb on a projecting stud.

Parker's hydraulic pen, invented about the same time, had a piston in the holder, operated by a serew stem and a nut on the end of the holder. The lower end of the reservoir being dipped in ink, the piston was drawn up by rotating the nut, filling the reservoir. The ink was ejected as required by the contrary motion of the thumb-nut.

Foun'tain-pump. 1. One in whieh a stream with a natural head is led through a

Fig 2090.





Fountain-Pump.

Fountain-Pen.

stock and nozzle, and thus bears the appearance of a pump, though perennial.

2. One in whieh a packed piston is replaced by a plunger with a leathern annular disk or diaphragm.

Four-cant. (*Nautical.*) A rope of four strands.

Four-chette'. 1. (*Surgical.*) An instrument

for holding up the tongue while the frenum is being cut.

2. (*Glove-making.*) The forked piece between two adjacent fingers of a glove, uniting the portions of the back and inside of the finger. *Fougette.*

Four'dri-nier'-ma-chine'. A paper-making machine, the first to make a continuous web. It was invented by Louis Robert, of Essonne, and patented by him in France. He experienced some pecuniary difficulties, and sold the right to M. Leger-Didot. The latter came to England and made arrangements for working it. A Mr. Gamble and the brothers Fourdrinier improved it, and made a valuable machine which was pirated, and bankrupted the gentlemen whose name is imperishably associated with it. The enterprise is the glory of the mechanical genius, and the disgrace of the law lords and law courts of the "tight little island."

The machine was perfected by Bryan Donkin, John Wilks, and others not known to fame.

The essential features of the machine are : —

1. A stream of paper pulp flowing on to the surface of an endless, horizontal, wire web.

2. A tremulous motion to the web to shake out the water, which falls in a rain beneath, and to felt the fiber.

3. A traveling deckle which keeps up with the motion of the web, and forms the lateral margin of the paper.

4. A porous *dandy* which presses the pulp and absorbs some of the water.

5. A couching roller to take up the web.

6. A pressure roller to abstract moisture.

7. Drying, sizing, finishing, measuring, cutting devices, *ad. lib.* See PAPER-MACHINE.

Four'gon. 1. A tumbrel or ammunition-wagon.

2. A French baggage-vehicle.

Fourth-rate. Formerly a 50 to 70 gun vessel, now a gunboat carrying from 1 to 4 guns.

Four-way Cock. A cock having two separate passages in the plug, and communicating with four pipes. The invention of James Watt.

Fig. 2091.

Four-Way Cock.

Fowl'ing-piece. A fire-arm adapted for ordinary sporting. See FIRE-ARM.

Fox. (*Nautical.*) A small strand of rope made by twisting several rope-yarns together. Used for *seizings, mats, sennits, gaskets.*

Fox-bolt. A description of bolt which is made tight by a *fox* or wedge driven into a split in the end. See BOLT.

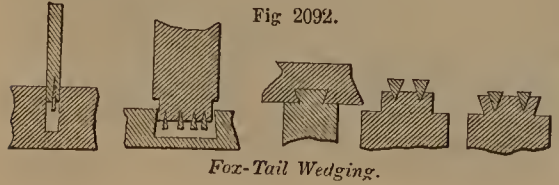
Fox'ing. (*Shoemaking.*) 1. An outer covering or upper leather over the usual *upper.* One mode of repairing a worn upper by clothing it.

2. Ornamental strips of a different material on the uppers of shoes.

Fox-key. (*Machinery.*) A split-cotter with a thin wedge of steel driven into the end to prevent its working back.

Fox-tail Saw. A dovetail saw.

Fig 2092.



Fox-Tail Wedging.

Fox-tail Wedg'ing. A mode of spreading the end of a tenon in the mortise, so as to give it a dovetail character to resist withdrawal. The same is applied to wooden pins which occupy holes not bored through. In the point of the pin is inserted a thin wedge of hard wood. When this reaches the bottom of the hole, it sinks into and spreads the end of the pin so as to bind it very firmly in the hole.

With a tenon, it is usual to insert a number of small wedges, so that it may not be split much at any one point.

Fox-type. (*Photography.*) A printing process in which a transparent positive is used, and the action of the light is the reverse of the usual process.

Foy'er. The crucible or basin in a furnace, to receive the molten metal.

Frache. A shallow iron pan to hold glass-ware while being annealed in a *leer.*

Frag'ments. (*Printing.*) A few pages at the end of a book. The title, preface, contents, etc., imposed so as to print off economically. *Oddments.*

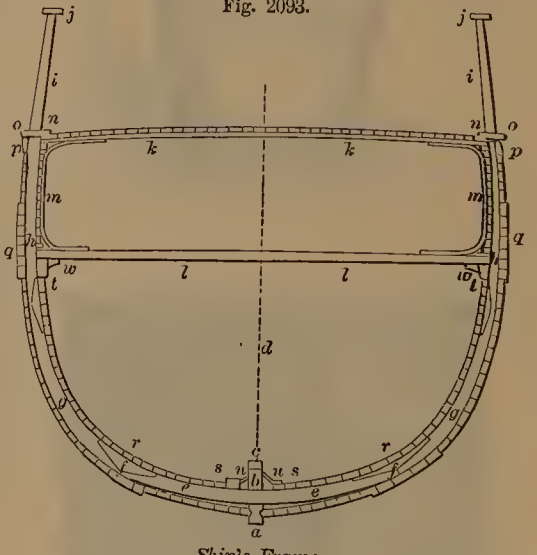
Fraise. 1. (*Fortification.*) Palisading placed horizontal at the crest of the scarp and projecting over the ditch.

2. A tool used by marble-workers to enlarge a hole made by a drill. It is grooved, and slightly conical.

Frame. The skeleton of a structure.

1. (*Shipbuilding.*) The parts of a ship's frame are shown in Fig. 2093, which represents a midship section.

Fig. 2093.



Ship's Frame.

a, keel.
b, keelson.
e, keelson-rider.
d, middle line or center line.
e, floor-timber, ground-futtock, or navel-futtock.
f, chock for filling to the timbers.
g, second futtocks.
h, top timbers.
i, rough-tree timber or stanchion.
j, rough-tree rail, or rail.
k, upper-deck beam.
l, hold-beam.
m, standard knees.
n, water-ways.
o, plank-shears.
p, sheer-strakes.
q, wales.
r, bilge-planks, inside and out.
s, futtock-planks.
t, clamps or sea-crafts.
u, limber-boards.
w, shelf-pieces or stringers.

2. The strong work which supports the engine and boilers of a locomotive upon the wheels, and known as *inside* frame or *outside* frame, according to the position of the wheels relatively to the frame.

3. The head of the batten in a loom.

4. The ribs and stretchers of an umbrella, or other structure with a fabric covering.

5. (*Carpentry.*) *a.* The skeleton structure of a wooden building, consisting of sills, posts, beams, sleepers, joists, and rafters, with the studding that is to form partitions.

b. The outward work enclosing a door or window.

c. The part of a door or window enclosing panels.

d. A border or inclosure for a picture, or panes of glass.

6. (*Horology.*) That which contains the mechanism of a watch or clock. It consists of two *plates* and a sufficiency of *pillars;* usually four.

7. (*Printing.*) A desk containing two pairs of cases, containing roman and italic letters for the use of a compositor (see CASE), or the stand supporting them.

8. A structure of four bars arranged in a square and adjustable in size, on which cloth or other fabric is stretched for quilting, embroidery, etc.

9. A term applied, especially in England, to machines built upon or within a framework of timbers — e. g. the *stocking-frame, lace-frame, water-frame, silk-frame,* etc. It is one degree more complex than the *quilting-frame, tambour-frame, embroidery-frame, glass* or *picture frame;* or a *window* or *door frame.*

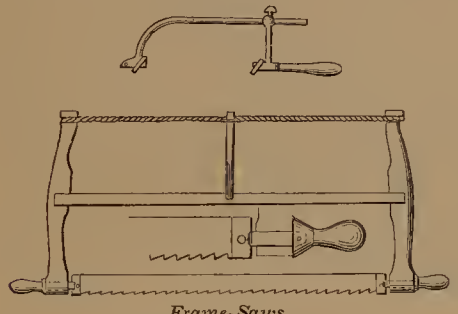
10. (*Soap-making.*) A box whose sides are removable when required, and locked together when the soap is to be poured in. As soon as the soap has acquired sufficient solidity, the sides are unlocked and taken down, exposing the block of soap, which is then cut up by wires which are passed through it to divide it into parallelopipeds.

Frame-lev'el. A mason's level.

Frame-saw. A thin saw stretched in a frame which gives it sufficient rigidity in its work.

The *buhl-saw,* for enlarging, is of this character. It is common to make the handle-attachment at each

Fig. 2094.



Frame-Saws.

end rotatable, so as to present the saw-edge in any direction.

A frame-saw is shown in a painting at Herculaneum. The sawyers are at each end, one standing and the other sitting. The bench to which the timber is secured by cramps is supported by four-legged stools. The saw-frame is square and the saw-blade is strained in the middle; the teeth stand perpendicularly to the plane of the frame.

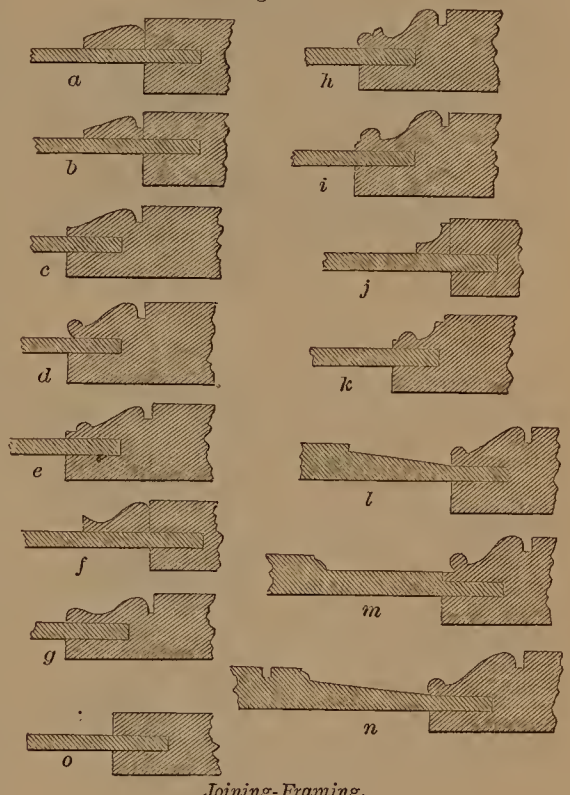
Frame-saws were common in Egypt many centuries previous to this time.

Fram'ing. 1. A mode of putting parts of a structure together

Joinery framing is of various descriptions, as square, bead, bead and fillet, ogee, etc., etc. See the following examples, which all have *flat panels and square backs*: —

a, ovolo and square.
b, quirk-ovolo.
c, quirk-ovolo fillet.
d, quirk-ovolo bead.
e, quirk-ovolo cock-bead or bead and fillet.
f, ogee and square.
g, quirk-ogee.
h, quirk-ogee and quirk-bead.
i, quirk-ogee, bead, and fillet.
j, cavetto.
k, cavetto, bead, and fillet.

Fig. 2095.



Joining-Framing.

The following vary in the *panels:* —

l, quirk-ovolo and bead, raised panel and square back.

m, quirk-ovolo and bead, raised panel with ovolo on the rising, and square back.

n, quirk-ovolo and bead, raised panel, with ovolo on the rising groove round the face, and square back. The list might be much extended.

o is square-framing, the simplest description of framing, having no molding on either side.

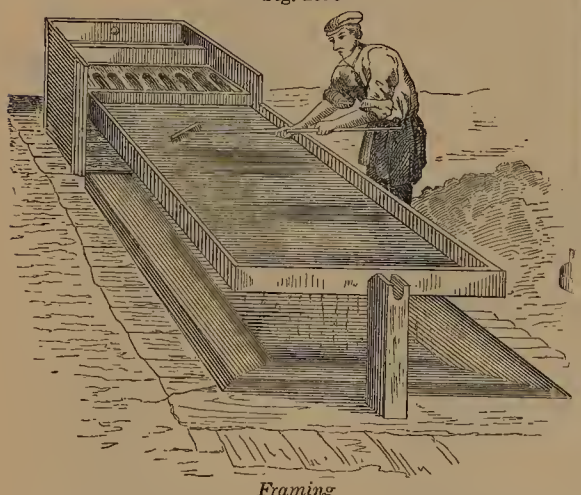
2. (*Mining.*) An operation upon pounded or stamped ores by which they are sorted into grades of comparative weight and consequent richness.

The *framing-table* is eight feet long, four feet wide, and has a ledge around it. It is suspended in an inclined position, on pivots, so that it may be tipped into a vertical position when full, discharging its contents into separate cisterns beneath; the reason for the separation of the receptacles will be apparent presently.

At the upper end of the frame is the jagging-board, over which the sluices are so distributed that a small stream of water shall carry them gradually down on to the frame. The richer portions of the ore rest upon the upper part of the frame, and the poorer, lighter portions are carried farther down; light impurities escape with the water at the lower part of the frame. The ore on the frame is occasionally stirred with a rake, that every portion may be subjected to the action of the water.

When the *frame* is sufficiently full, the latch which held it horizontal is lifted, and the frame tipped up into a vertical position, so as to tip out its contents, which fall into the vats beneath. These

Fig. 2096.



Framing

vats are arranged in a row, so that they may respectively receive the *slimes* which have accumulated nearer to or farther from the head of the frame, the richness being determined by the proximity to the head or upper portion. The frame is then readjusted, a quantity of slimes spread on the *jagging-board*, and the operation recommences.

The contents of the cisterns are treated by subsequent processes of a nature adapted to their respective qualities. Analogous processes are described under BUDDLE; TRUNK; KEEVE; JIGGER; TYE, etc. (which see).

Fram'ing-chis'el. (*Carpentry.*) A heavy chisel for making mortises. It has a socket-shank which receives the wooden handle on which the blows of the mallet are delivered.

Frank'ing. (*Joinery.*) The notching out a portion of a sash-bar for the passage of the transverse bar, to make a miter-joint.

Frap'ping. 1. (*Nautical.*) *a.* The binding together of the several ropes of a tackle at a point between the blocks, so as to increase still farther the tension.

b. Securing a ship in emergency by wrapping ropes around it, to prevent starting of the planks.

"They used helps, undergirding the ship."—*Luke's account of Paul's voyage.*

2. Bracing the cords of a drum by pulling them together.

Free'board. (*Shipwrighting.*) So much of the vessel's side as is included between the *plank-sheer* and the water-line.

Free-reed. (*Music.*) An elastic tongue, usually of brass, and playing in a long rectangular opening in a plate to which one end of it is riveted. The name *free-reed* is given to distinguish it from the reed which batters against the seat, as in the clarinet, some organ-pipes, the bassoon, and oboe. These *battering*-reeds are usually of wood. The *free-reed* is used in the accordeon, melodeon, concertina, harmoneon, parlor-organ, and in most of the reed-pipes of organs.

Fig. 2097.

Free-Reed.

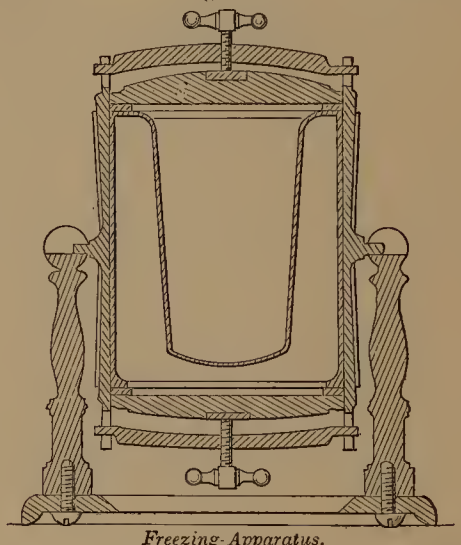
The opening in the plate is slightly larger than the margin of the tongue, so that the portion of the latter concerned in the vibration does not batter against or touch the plate. At one end is a stud by which the plate is drawn in or out from the seat of the reed over the aperture whence it derives the air-blast producing the vibration and the consequent musical tone. At some point on the plate is denoted the note to which the tongue is tuned.

Free'stone. An oölitic stone, so called from the facility with which it is rived in any direction.

Free-stuff. (*Carpentry.*) Timber free from knots. *Clear-stuff.*

Freez'er. An apparatus in which cream or other food is placed to be frozen. In the example, the liquid to be congealed or cooled is contained in a metallic cylinder inclosed by another cylinder and surrounded by the chemical refrigerating substances, the apparatus being rotated or oscillated to thoroughly agitate the liquids, and bring new particles to the cold surface.

Fig. 2098.



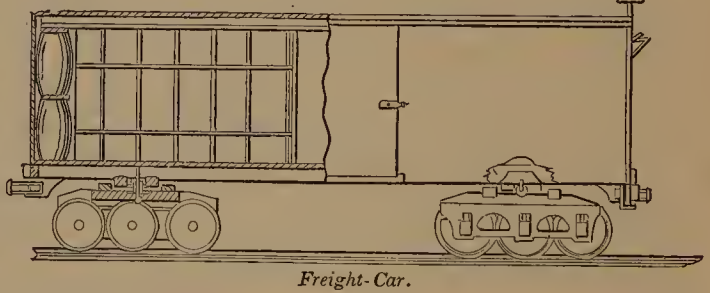
Freezing-Apparatus.

Master's machine for icing drinks consists of a central cylinder for the confectionery, a surrounding cylinder for the freezing mixture, and one outside of this again, for containing water. The inner cylinder is rapidly revolved, its contents become frozen, and the water in the outer vessel becomes a hollow cylinder of ice, in which a decanter may be set to ice its contents.

Freez'ing-mix'ture. A mixture of salt and pounded ice; or a combination of chemicals with or without ice. See ICE-MAKING.

Freight-car. One constructed for the carriage of merchandise.

Fig. 2099.



Freight-Car.

Freight-en'gine. (*Steam Engineering.*) A locomotive adapted for drawing heavy trains at moderate speed. The drivers are coupled together so as to increase adhesion, and are of smaller diameter than usual with passenger engines adapted for more rapid transit.

French-bit. (*Carpentry.*) A boring tool adapted to use on a lathe-head or by a bow. It is intended for boring hard wood, and approaches the characteristics of a *drill*. See BIT.

French-fly'ers. (*Carpentry.*) Stairs that fly forwards until they reach within a length of a stair from the wall, where a quarter space occurs; the steps next ascend at a right angle, when another quarter space occurs; they then ascend in an opposite flight, parallel to the first direction.

French-horn. A wind-instrument formed of metal, having a circular shape and a gradual taper from the mouth-piece to the flaring pavilion. See HORN.

French-pol'ish. A solution of resin or gum resin in alcohol or wood naphtha. A good recipe is, shellac, 1½ pounds; spirits of wine, 1 gallon. Or, shellac, 2½ lbs.; gum mastic and sandarac, each 3 ounces; alcohol, 1 gallon; copal varnish, 1 pint. Or for a dark color, shellac, 1 pound; benzoni, ½ pound; alcohol, 1 gallon. Or, shellac, 1½ pound; guaiacum, ¼ pound; alcohol, 1 gallon.

It is laid on with a sponge, a brush of wadding enveloped in a rag, or a rubber made of a roll of list. These are saturated with the varnish which they gradually yield by pressure to the surface of the wood, over which they are kept in constant motion in uniform circular strokes. The surface of the rubber is covered with an oiled cloth, which is renewed as it becomes clogged.

French-roof. A roof having portions of two different pitches. A *curb* roof. A *Mansard* roof.

French-win'dow. A large casement window, moving on hinges instead of sliding vertically in grooves. A *casement*.

Fres'co. A mode of painting in which the colors are mixed with and laid on in the manner of plaster.

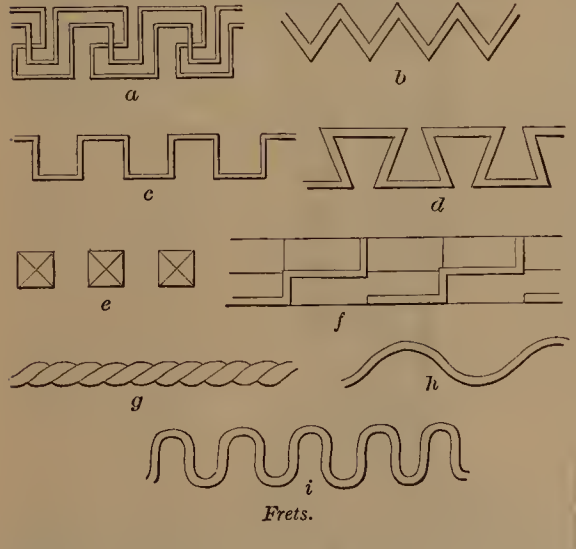
The picture is prepared as a cartoon, and is pricked through on to the soft surface of plaster upon which the fresco is to be placed.

The surface is rough, and is damped to receive the colors, which are mixed and ground up with lime.

A solution of silex instead of lime was used by Oberrath von Fuchs, being laid on a chemically prepared ground. It becomes exceedingly hard.

Fret. 1. An ornament of zigzag, interlacing, or variously contorted fillets, used as an architectural decoration. Some frets are included in the following:—

Fig. 2100.



Frets.

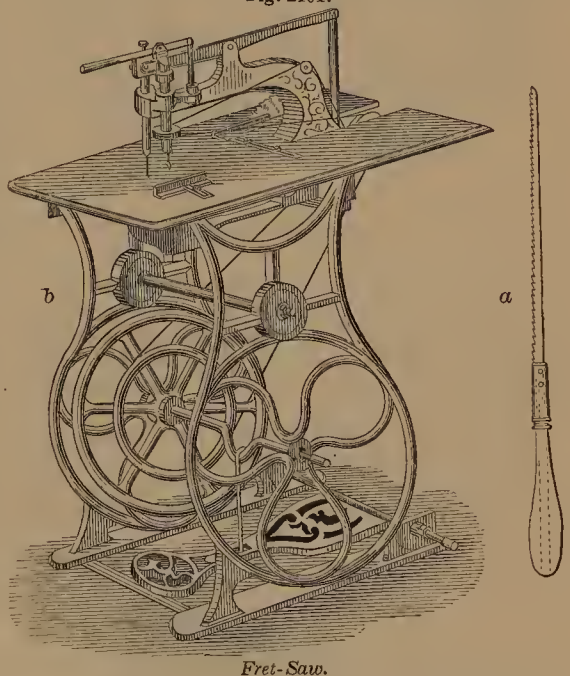
a, intersecting fret.
b, zigzag or chevron molding.
c, embattled fret.
d, triangular fret.
e, nail-head fret.
f, billet-fret.
g, cable-molding.
h, wavy molding.
i, nebular molding.

2. (*Music.*) One of the bars of wire on the finger-board of a guitar and some other instruments, to indicate where the fingers are to be placed for playing certain notes.

Fret-saw. 1. A saw (*a*) with a relatively long, narrow blade, used in cutting the frets, scrolls, etc., on verge boards, ornamented screens, etc. A *key-hole saw*; a *compass-saw*.

2. A machine (*b*) mounted on a stand with a treadle to give the reciprocating motion to the gig-saw. The machine shown is specially intended for fret-work on a small scale, ornamental inlaying, buhl and reisner work (which see).

Fig. 2101.



Fret-Saw.

Fret-work. 1. (*Glazing.*) A mode of glazing in which a number of separate pieces of stained glass are fitted together in leaden *cames* so as to form paterns. The *cames* are fastened by leaden bands to *saddle-bars* of iron, which cross the window-frame.

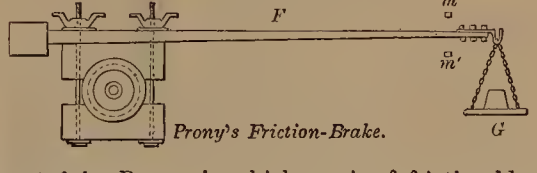
2. (*Wood.*) Carved or open wood-work in ornamental patterns and devices.

Fri'ar. (*Printing.*) A pale patch in a printed sheet.

Fric'tion-balls. Balls placed beneath a traversing object to relieve friction. Some forms of swing-bridges are thus supported. Properly, *anti*-friction balls.

Fric'tion-brake. A form of dynamometer invented by Prony, in which a pair of friction-blocks are screwed to a journal rotating at a given speed,

Fig. 2102.

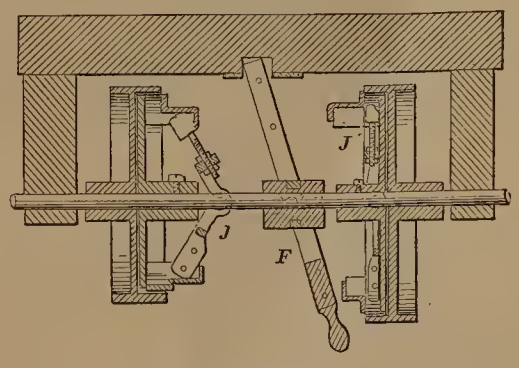


Prony's Friction-Brake.

and tightened to such an extent that the unweighted lever will remain horizontal between the studs *m m'*.

The shaft is now set in motion by the prime mover, the screws are then gradually tightened to such a degree that the shaft moves exactly with the velocity at which its useful effect has to be determined. Were it not for the stud *m*, the lever, with the whole brake apparatus, would move round in a circle with the shaft, so that this stud has to withstand a certain force from the lever pressing against

Fig. 2103.



Brown's Friction-Clutch.

it. Now place gradually upon *G* such a weight as will counteract the pressure of the lever against *m*, and bring it back to its horizontal position. It is evident that this weight, in combination with the lever *F*, expresses the amount of friction between the blocks and the drum.

Fric'tion-clutch. A device for connecting two shafts by bringing a piece on one shaft in contact with a piece on another shaft, which revolves with such force that the former partakes of the motion of the latter.

In Fig. 2103, the shipper-handle *F* carries the shaft, and with it the toggles *J J*, expanding the segments against the rim of the pulley. See also CLUTCH.

Fric'tion-cones. A form of friction-coupling in which the connecting portions have respectively a conical disk and a hollow cone, which become frictionally adherent by contact.

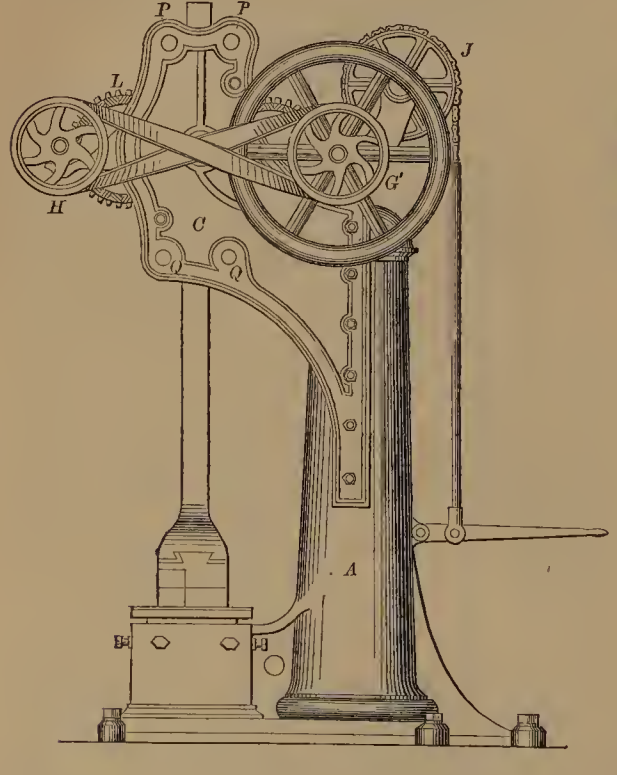
Fric'tion-coup'ling. See FRICTION-CLUTCH.

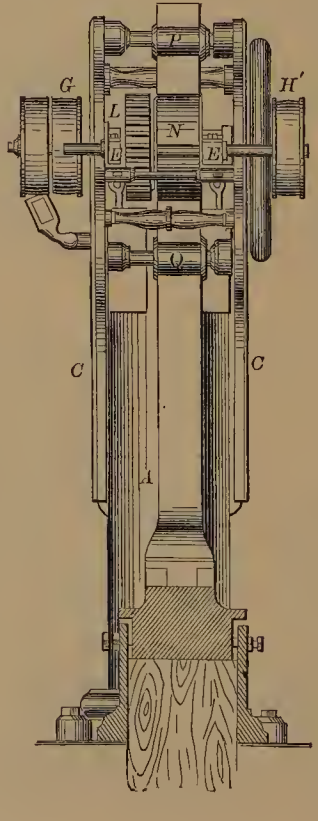
Fric'tion-gear. Wheels which act upon each other by the adhesion of their contacting surfaces, instead of by cogs, bands, or chains.

Fric'tion-ham'mer. One deriving its name from the hammer being lifted by means of the friction of revolving rollers, which nip the hammer-rod. The framework consists of a pillar *A*, to which are bolted the two cheeks *C C* carrying the working apparatus. On the oscillating frame *E E* are the plummer-blocks for the spindles, carrying the driving gear and friction-rollers. The motion is, in the first instance, communicated to the drum *G*, and consequently to *G'*, fixed upon the same shaft; this communicates the motion by means of a crossed strap to the drum *H*, and hence also to a pinion which works into the spur-wheel *L* fixed upon the same shaft with the friction-roller *N*. In a similar manner, a friction-roller on the other side of the hammer-rod is set in motion by means of a spur-wheel and pinion deriving motion from the drum *G'*.

The friction-rollers have wooden rims. The oscillating frame *E*, when tilted upon its axis, causes the friction-rollers to nip the hammer-rod, the one a little above, the other a little below, the axis. When the frame *E* resumes its horizontal position, the hammer is allowed to fall, being guided by the rollers *P P* and *Q Q*. The tilting of the frame is done by means of the lever, connected with the same by means of the rod and chain passing over the fixed pulley *J*.

Fig. 2104.





Friction-Hammer.

Fric'tion-pri'mer. A small brass tube filled with gunpowder, and having a smaller tube containing friction composition inserted at right angles near the top. The composition is ignited by means of a roughed wire inserted in the smaller tube, which is rapidly drawn out by a lanyard having a hook at the end.

The composition consists of 2 parts sulphuret of antimony and 1 part chlorate of potassa, moistened with gum water and dried.

Fric'tion-pul'ley. See FRICTION-CLUTCH; CLUTCH.

Fric'tion-tube. (*Ordnance.*) A tube containing a composition which is inflamed by friction, and which is placed in the vent of a gun to ignite the charge

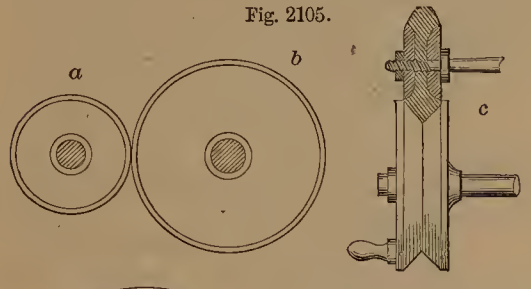
when the lanyard is pulled. See FRICTION-PRIMER.

Fric'tion-wheel. A wheel the motion of which is caused by the friction of a moving body, or, conversely, which communicates motion to a body by frictional contact. In the annexed illustration *a b*, one wheel being driven becomes a motor to the other, their perimeters being in contact. The surface is usually clothed with leather, rubber, or some sufficiently elastic material which does not polish too readily, and thus induce slipping.

By grooving the perimeters of the wheels, the contact may be made more intimate, as the surface engaged is increased, and the elastic material of the respective faces caused to bind.

The term *friction-wheel* is often, but erroneously, applied to wheels which diminish friction; these are properly called ANTI-FRICTION WHEELS (which see.)

Fig. 2105.



Friction-Gearing.

Howlett's friction gearing *c* has an upper india-rubber wheel with a V-edge, clamped between two metallic plates. By screwing up the nut which holds the parts together, the disk is made to expand radially, and thus increase the tractive power on the lower driving-wheel.

d shows another form. A collar fastened to the central shaft has four pivoted arms. When the rim turns in one direction, the arms turn on their pivots, leaving the rim and failing to transfer the motion to the shaft.

When the rim turns in the contrary direction, the arms catch against it and are rotated by the contact, turning the shaft also.

The friction-wheel feed, by which logs are fed to the gang-saws in the large lumber-mills of Ottawa, Canada, consists of a horizontal wheel 40 inches in diameter, and an upright one driven by band from the engine-shaft, and 24 inches diameter. (See Fig. 1601.)

The horizontal wheel is vertically adjustable by a hand-wheel and shaft on the working floor of the mill, the friction-wheel slipping on a spline. As the said wheel approaches towards the center of the driving-wheel, the speed of the feed is lessened, and conversely; if it cross the center, the motion is in the other direction, and the feed is reversed.

Frieze. 1. (*Architecture.*) A flat member of an entablature between the architrave and cornice.

Frieze-panel; one of the upper panels of a six-panel door.

Frieze-rail; the one next to the top rail.

2. (*Fabric.*) A coarse woolen cloth.

Frig'ate. (*Vessel.*) The original frigate was a Mediterranean vessel propelled by sails and oars.

It is now a vessel of war, having an upper flush deck (spar-deck) and one covered gun-deck (main-deck). The armament is from 28 to 44 guns.

The grade is below a man-of-war and above a *corvette*. The rating of iron-clads is different; the guns being larger and fewer in number.

Frig'a-toon. A Venetian vessel with a square stern, main-mast, jigger-mizzen, and bowsprit.

Frig'er-a-to-ry. A cooling-chamber.

A chamber maintained at a low temperature for the preservation of meat or vegetables.

Frill'ing. A species of plaited or fluted edging or trimming of fine linen. The gathered or plaited edge is sewn to a band, and the crimped or ruffled edge forms a collar, a cuff, or an ornament to a shirt-front.

Fringe-loom. One in which the weft-thread is carried and detained beyond the limit of the warp, which has thus a series of loops beyond the selvage.

Frisk'et. (*Printing.*) A rectangular frame having tapes, cords, or paper stretched across it for holding the sheet to the *tympan*.

The frisket is a frame around the type-form, and keeps the margin of the paper clean.

Frit. (*Glass-making.*) A calcined mixture of sand and fluxes ready to be melted in a crucible to form glass.

The term is also applied to other vitreous combinations or compositions for use in manufacturing. It is not applied to manufactured articles, but to those in course of conversion, as the calcined kelp and lead, which are ingredients in the glaze of delft-ware.

A *frit-mixer* is a horizontal cylinder with oblique beaters, or a box with semi-cylindrical bottom and a rotating shaft with beaters or stirring arms.

Frit-brick. (*Glass-making.*) A lump of calcined glass materials, which have been united and brought to a pasty condition in a reverberatory furnace preliminary to the perfect vitrification in the melting-pot. See FRITTING-FURNACE.

Frith. (*Hydraulics.*) A fish-weir.

Frit'ting-fur'nace. (*Glass-making.*) A reverberatory furnace in which the materials for making glass are calcined (*fritted*) as a process preliminary to melting. The object is to effect a partial union of the silicic acid and alkali, to avoid volatilization of the latter in the subsequent vitrification.

The materials (sand, chalk, soda-ash, and cullet) being introduced into the furnace, the temperature is gradually raised for three hours. The pasty mixture is stirred, and the temperature increased to incipient fusion. The stuff is then raked out and transferred to the melting-pot, or is placed in cast-iron trays, cut into blocks by a spade, and stored away as *frit-bricks*.

Fri'zel. The movable plate of steel placed vertically above the pan of a gun-lock to receive the blow of the *snaphance*. The form of flint-lock which superseded the wheel-lock.

Friz'zing. 1. (*Leather-manufacture.*) A process to which *chamois* and *wash* leather are subjected after the skins are *unhaired*, *bated*, *scraped*, *fleshed*, and *raised*.

It consists in rubbing the skins with pumice-stone or a blunt knife till the *grain* appearance is entirely removed, the surface softened, and an even thickness obtained throughout.

2. (*Fabric.*) A peculiar finish given to certain kinds of cloth. See next article.

Friz'zing-ma-chine'. 1. (*Fabric.*) A machine on which the nap of woolen cloth is formed into a number of little prominences or tufts. Petersham cloth, so called, is thus formed.

The machine consists of three parts, — the *frizzer*, the *frizzing-table*, the *drawing-beam*. The cloth is drawn by the beam between the two former portions, which are respectively about ten feet long, fifteen

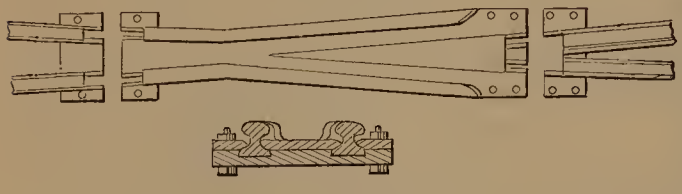
inches wide, and laid parallel, a short distance apart. The *table* is underneath, and its upper surface is covered with a coarse nappy cloth. The *frizzer* has a slow semicircular motion, and its surface is incrusted with a cement composed of glue, gum-arabic, and yellow sand.

The *drawing-beam* is covered with sharp points, and drags the cloth between the frizzer and the table, the latter preventing its being shifted about by the rotary reciprocation of the frizzer above, whose numerous protuberances catch the fibers of the cloth under treatment and roll them into little aggregated tufts or bunches, as the cloth is fed gradually through.

2. (*Wood-working.*) A bench with a circular cutter-head slightly protruding above the working surface, and adapted to dress boards which are passed over it.

Frog. 1. A section of rail at a point where rails diverge, or one track leads to two branches. In the illustration, a feature of connection is introduced,

Fig. 2106.



Railway-Frog.

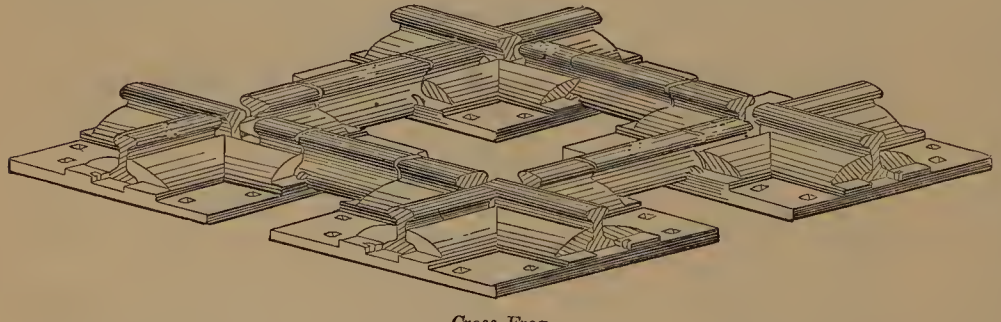
the end of the frog being dovetailed to receive the necks of the rails, and a chair placed under the dovetailed end. The chair has one or two recesses to support the rails, and suitable holes to receive the bolts.

A *cross-frog* is one placed at a rectangular intersection of railroad tracks.

2. A button or toggle of spindle shape and covered with silk or other material, which is passed through a loop on the opposite side of the breast of a military cloak or overcoat, serving to fasten the two breasts together.

3. The loop of a bayonet or sword scabbard.

Fig. 2107.



Cross-Frog.

Frog-plate. An accessory to the compound microscope in which the web of a frog's foot is exposed on the stage, to exemplify the circulation of the blood.

Front. (*Fortification.*) Two half-bastions and a curtain.

Fron'ton. (*Architecture.*) The decorated entranee to a building consisting of a cornice supported by consoles and surmounted by a pediment.

Frost'ed. The dead or lusterless appearance of gold, silver, or glass, when polishing the surface is omitted. It is supposed to resemble the *hoar-frost*, and hence the name.

Frosted work is introduced as a foil or contrast to *burnish* work, in which the metal receives the full luster by an agate or flint burnisher.

Electro-plated work is in the frosted condition as it comes from the bath, and may be burnished in whole or in part.

The frosted appearance on glass is given by grinding, making *ground glass*, which diffuses the rays, and does not transmit a direct ray or a clear image.

Frost'ed-glass. (*Glass-manufaeture.*) A form of glass formerly made by the Venetians, and recently revived by Apsley Pellatt, who thus describes it: —

"Frosted glass has irregularly varied marble-like projecting dislocations in the intervening fissures. Suddenly plunging hot glass into cold water produces crystalline convex fractures, with a polished exterior, like Derbyshire spar; but the concave intervening figures are caused, first by chilling, and then reheating at the furnace, and simultaneously expanding the reheated ball of glass by blowing, thus separating the crystals from each other, and leaving open figures between, which is done preparatory to forming vases or ornaments. Although it appears covered with fractures, it is perfectly sonorous."

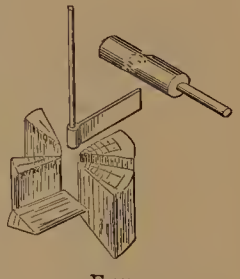
Frost-lamp. An oil-lamp placed beneath the oil-tube of an Argand lamp to keep the oil in a flowing condition on cold nights. Used especially in lighthouses.

Frost-nail. A roughing nail; driven into a horse's shoe in slippery weather.

Frow. (*Coopering.*) A cleaving tool for riving staves, shingles, or clapboards from the *balk* or *juggle*. *Frower*, *froe*.

It has a sharp edge, wedge-shaped blade, and a handle set in the plane of the blade, but at right angles to its length. It is driven by a mallet.

Fig. 2108.



Frow.

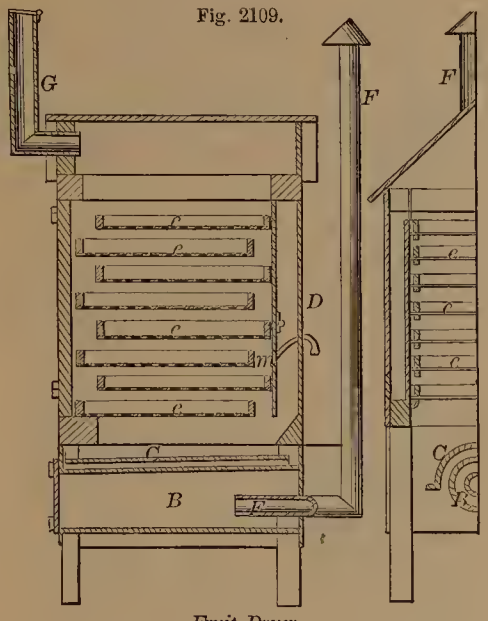
Frow'er. A FROW (which see).

Fruit-box. A small box of certain dimensions in which fruit is shipped to market. Berry-boxes are made of strawboard, scaleboard, splints, and many other materials. Some of them are intended to be so cheap as to be sold with the fruit, others are frustums which pack in nests, others are collapsible for back shipment.

The larger fruits are carried in small crates, or open boxes made of slats.

Fruit-dry'er. A small house or kiln with furnace, shelves, and means for ventilation, used for drying fruits. There are many forms, which differ mainly in the arrangement of the parts named. In the example, the fire is made in furnace *B*, the heated surrounding air is deflected by plate *C*, passes in a

Fig. 2109.



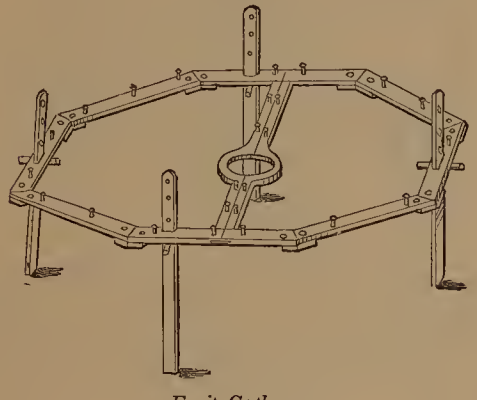
Fruit-Dryer.

sinuous course up among the shelves *e e*, and out at the duct *G*. The furnace *B* has its own flue *F*.

Fruit-frame. A trellis or espalier.

Fruit-gath'er-er. They are of two kinds. One in which a canvas is stretched beneath the tree to catch the fruit without bruising, as in Fig. 2110, which

Fig. 2110.

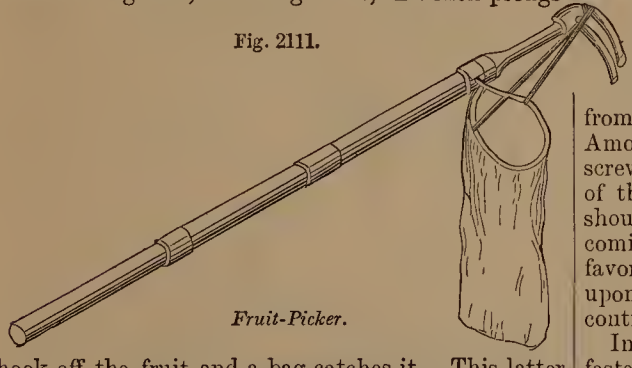


Fruit-Gatherer.

shows a jointed frame, over which a sheet is secured by the pins, the inner ring encircling the trunk.

Another form is really a fruit-picker, being on the end of a long staff, as in Fig. 2111, in which prongs

Fig. 2111.

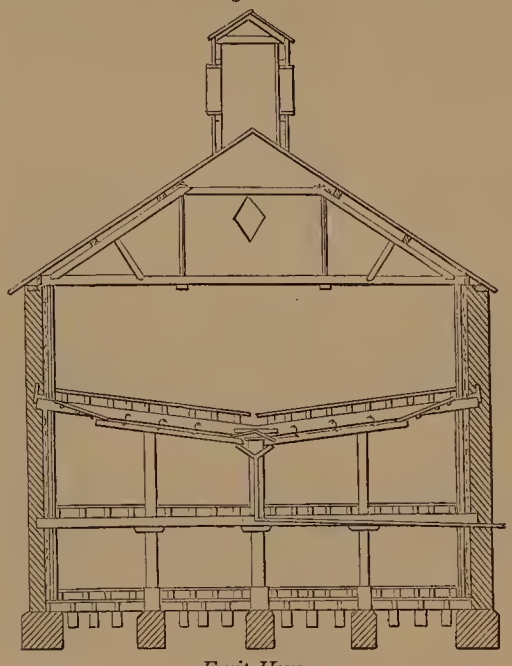


Fruit-Picker.

hook off the fruit and a bag catches it. This latter kind has many varieties, with different modes of grasping or cutting, catching, and leading down the fruit.

Fruit-house. A storage house for fruit. The walls hove double thickness, with intervening non-

Fig. 2112.



Fruit-House.

conducting material, and provision is made for effective ventilation.

The walls and floors have wooden surfaces with non-conducting linings or blank spaces between all inner surfaces and the outer walls or the earth. Ventilating entrances are at the level of the ice-floor, with hatches opening down to the storage rooms, and inclosed spaces to carry off bad air through the mass of ice upward when it is light air, and downward out at the bottom of the entrance-doors when it is carbonic-acid gas, the light air passing through the upper space above the ice, and thence out at the windows of the observatory.

Fruit-jar. Jars for preserving fruit are made of earthenware or glass, especially the latter. Some have been made of metal with porcelain (so called) lining, but these have met with little favor, as the acids of the fruits attack the lead of the enamel and destroy it, and themselves become unwholesome. The same remarks apply to the earthenware, whose glazing has generally salts of lead, and is therefore unfit for the purpose. Some kinds of glass even, where lead has been used as a flux, are not entirely beyond suspicion. Glass jars were formerly blown, like bottles, but are now usually pressed and blown in molds. The exercise of ingenuity has principally concerned the modes of closing, to render them air-tight, protecting the contents from access of oxygen and consequent fermentation. Among the devices for this purpose are lids which screw down on the threaded neck of the jar, the edge of the lid coming against a caoutchouc gasket on a shoulder of the jar, or a gasket on the lip of the jar coming against the inner surface of the lid. Another favorite form is a flat or flanged lid pressed down upon a gasket on the lip by some mechanical locking contrivance.

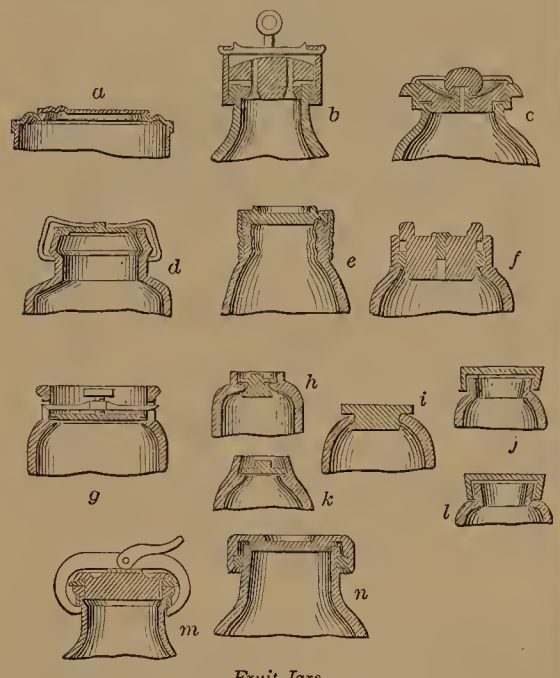
In the illustration are shown several forms of fastening the lid hermetically to the jar, after filling the latter and driving out a small remainder of air by the steam of the heated contents.

a is a tin can with a lid whose flange dips into a

trough on the can, which is closed by wax that is run into the trough.

b has a cover secured by hooks and a yoke, and pressed down upon a gasket on the lip. The holes in the lid are for the filling of any remaining space and the escape of the residual air. They are then both stopped.

Fig. 2113.



Fruit-Jars.

c has a cover secured by an elastic band which is held by lugs on the neck of the jar.

d has a cover secured by a yoke whose ends pass beneath inclined lugs on the neck so as to screw down the lid as the yoke is rotated.

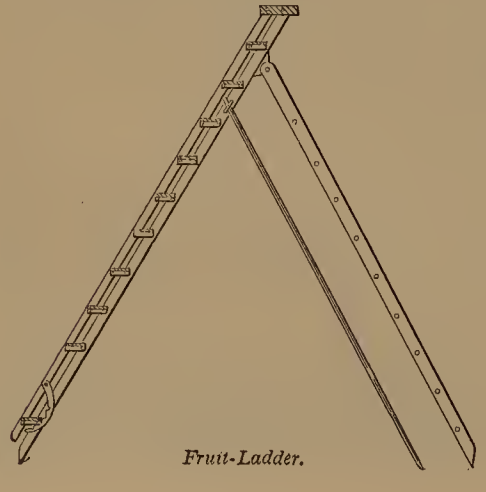
e has a glass lid, depressed by a sheet-metal screw collar, which engages the threaded neck of the jar.

f has a glass screw-stopper whose threads imbed themselves in the elastic gasket which is held in an interior groove of the neck.

g, a yoke fits in slots in the neck, and holds a center screw which presses the cover upon the gasket.

h i j k l are all forms in which an oval mouth admits the oval flange of the lid; the rotation of the latter brings the major diameter of the flange coincident with the minor axis of the opening, and locks the flange under the neck of the bottle.

Fig. 2114.



Fruit-Ladder.

m has a cover locked by a yoke and cam.

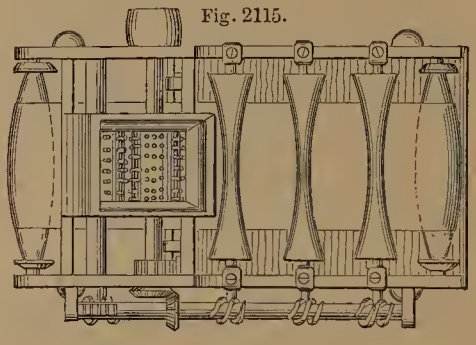
n has a grooved lid which holds the lip of the neck, and has a shoulder which fits against a gasket round the neck.

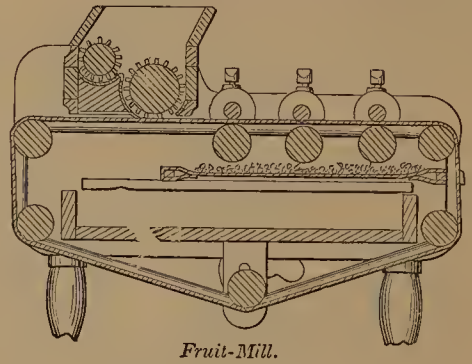
Fruit-knife. A knife for cutting fruit, having a blade which is not acted upon perceptibly by the acids of the fruit. Silver is the usual material.

Fruit-lad'der. A light ladder to rest against the limbs of the tree, or stand by itself while the picker stands upon it to gather fruit.

Fruit-mill. A mill for grinding grapes for must or apples for cider. (See CIDER-MILL.) The example shows a pair of studded grinding rollers, an apron

Fig. 2115.





Fruit-Mill.

on to which the fruit falls and is carried between several consecutive pairs of rollers, which express the juice.

Fruit-pick'er. An implement for reaching up to and picking fruit from a tree. Three forms of many are shown. One (Fig. 2116) has two sliding prongs *d*, which, by means of the rope *c*, are pulled down upon the jaws *c*. The fruit drops into a basket.

Fig. 2116.

Fruit-Picker.

Fig. 2117 has a metallic hoop around the mouth of the bag. The edges of the flange around the notch are sharpened, the better to cut the stem and detach the fruit; and the band or casting has a stem or projection by which it is attached at an angle to the handle.

In Fig. 2118 a vertical blade is fixed to the end of the handle, and against this blade another is caused to work like a pair

of shears, the movable blade being operated by a cord and spring. The stem of the fruit is cut, the fruit falling into a pocket attached to the top of the pole.

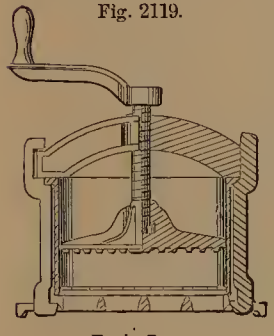
Fig. 2117.

Fig. 2118.

Fruit-Pickers.

Fruit-press. One for expressing the juice of fruit. The subject is considered under CIDER-PRESS (which see). The example shows a small domestic press for fruit, such as those used in limited quantities for currant-wine, jellies, etc.

Fig. 2119.



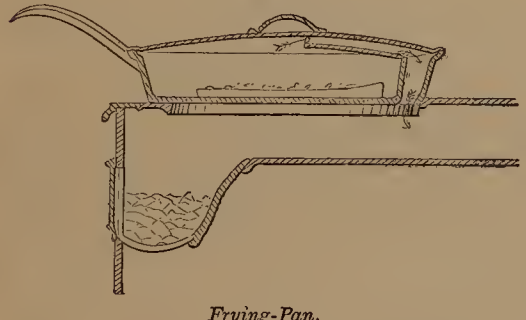
Fruit-Press.

Fry'ing-pan. A pan in which food is cooked in fat. In the illustration, a duct leads the fumes of the cooking down into the stove-flue.

Fudge-wheel. (*Shoemaking.*) A tool to ornament the edge of a sole.

Fu'el, Ar'ti-fi'cial. Agglomerated peat, sawdust, coal-dust, and slack, one or more of them in various combinations, bound together, by heavy pressure, with cements, clay, coal-tar, or the residuum of

Fig. 2120.



Frying-Pan.

starch-manufacture. The latter is used in the Belgian and Austrian works. Dehaynin's works in Belgium turn out 175,000 tons of this fuel per year. It leaves six per cent of ashes. The Northern Railway of Austria has works which produce 15,000 tons per annum; prisms $9 \times 5 \times 4\frac{1}{2}$ inches, weighing eight pounds, evaporating seven pounds of water per pound of fuel. The coal is compressed with the refuse of starch-works as a cement, and dried in a kiln heated overhead by a current of hot air.

Small coal two parts and clay one part, molded into blocks like cannon-balls and dried, have been used for a century past in Hainault. — *London Monthly Magazine*, April 1, 1800.

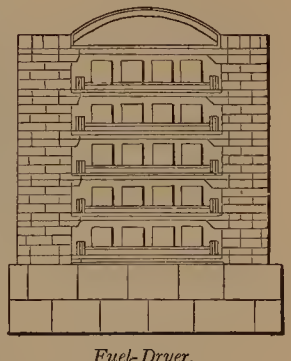
Peat and turf cut into blocks and dried have been used any time these thousands of years past, but the business of preparing peat-fuel by mechanical means and by admixtures is comparatively modern. (See PEAT-MACHINE.) In 1603 Sir Hugh Platt published a book in which he described a new fuel block made of coal and loam in "the manner of Lukeland of Germanie." He also used coal-slack, sawdust, tanner's bark, aggregated by loam and cow-dung. Chabanne's English patent of 1799 claimed separating the large coal from the small coal by passing the latter through sieves or gratings made of wood or metal, and then consolidating the small coal by mixing it with earth, clay, cow-dung, tar, pitch, broken glass, sulphur, sawdust, oil-cakes, tan, or wood, or any other combustible ingredient, to be mixed together and ground with a wheel in water, in a wooden vessel; this mixture he afterwards placed in pits provided with drains for the water to run off, and then, when dry, molded the mass into cakes of a considerable size.

The following United States patents may be consulted: —

13,056	1855.	44,262	1864.
15,688	1856.	44,940	1864.
26,541	1859.	47,296	1865.
35,472	1862.	50,588	1865.
40,753	1863.	51,833	1866.
40,791	1863.	53,431	1866.
40,920	1863.	55,369	1866.
42,163	1864.	61,006	1867.
43,112	1864.		

Fuel-dry'er. A kiln for drying blocks of artificial fuel. The trays supporting the blocks of fuel run upon rollers upon the angle-iron bars secured in the walls. The walls have perforations to allow the escape of the vapors resulting from the drying of the blocks. Either heated air or steam-pipes may be placed between the trays. The ends of the chamber may be closed by metallic doors.

Fig 2121.



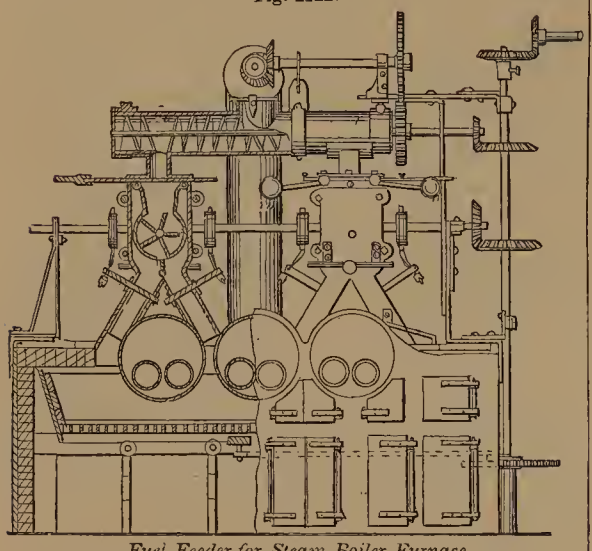
Fuel-Dryer.

Fu'el-feed'er. A device for feeding fuel in graduated quantities to a furnace, either for metallurgical purposes or for steam-boilers. The example shows an apparatus for carrying coal, sawdust, and other fuel, from a bunker to the furnace, and feeding it regularly and evenly upon the grate under the boilers. It is worked by the engine. It will be readily understood without specific description. James Watt, 1769, and some even before him, tried to feed furnaces mechanically to save fuel. Some of the devices are noted under SMOKE-CONSUMING FURNACE (which see).

Fu'el Press, Com-pressed'. A machine for compressing coal-dust and a cementing material into a block.

In one form the material is forced within cylindri-

Fig. 2122.



Fuel-Feeder for Steam-Boiler Furnace.

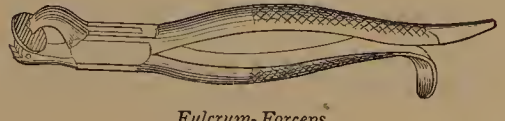
cal pipes of cast-iron by the resistance offered to its passage through the pipe, and caused by the friction of the material against the sides of the pipe. The compressed fuel passes out of these cast-iron pipes, as a continuous cylindrical bar, which is broken in suitable lengths, and sold in the form of round logs.

Mazeline's machine produces bricks of prismatic form. It consists of a mixing apparatus, which feeds the material into a machine, having twelve square molds arranged in a circular frame, which has a rotating movement. Each die is worked by a square piston projecting into it from the bottom, and acted upon by an inclined plane which presses the pistons upward during the revolution of the circular frame, so that each brick is completed and delivered by the respective mold, making one complete turn round the central axis of the machine. See PEAT-MACHINE.

Ful'crum. A prop or support; the point on which a lever turns.

Ful'crum For'ceps. A dentist's instrument in which one beak is furnished with a hinged plate

Fig. 2123.



Fulcrum-Forceps.

which bears against one side of the object, while the other beak has the usual tooth or gouge shape.

The plate is covered with an india-rubber pad or cushion about ⅛ of an inch thick, secured by fine wire. The pad rests on the gum.

Ful'gu-ra'tion. (*Metallurgy.*) The sudden brightening of gold or silver in the crucible as the last traces of dross leave the surface.

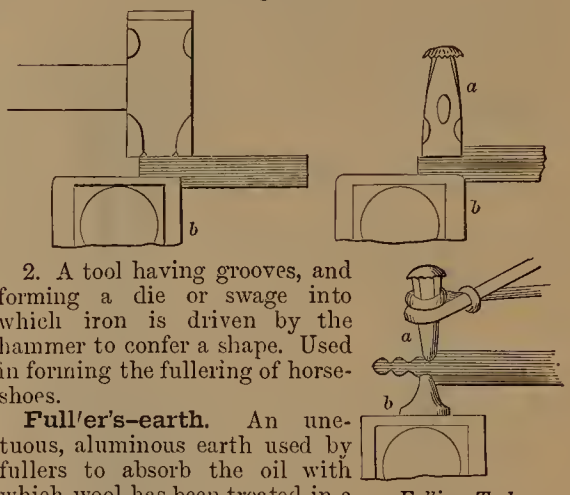
Full-bound. (*Bookbinding.*) Covered with leather.

Full-cen'ter Arch. A semicircular arch or vault. One describing the full amount of 180°.

Full'er. (*Forging.*) 1. A tool, sometimes known as a *creaser*, struck by the hammer or placed in the hardy hole of the anvil and employed to swage down or spread the iron by a series of parallel indentations.

The tools are known respectively as the *top* (*a*) and *bottom fuller* (*b*).

Fig. 2124.



Fulling-Tools.

2. A tool having grooves, and forming a die or swage into which iron is driven by the hammer to confer a shape. Used in forming the fullering of horse-shoes.

Full'er's-earth. An unctuous, aluminous earth used by fullers to absorb the oil with which wool has been treated in a previous part of its manufacture.

Full'ing. A process by which cloth made of a felting fiber is condensed, strengthened, and thickened, with a loss of width and length. Some fibers will felt, others will not. (See FELT.) In felting, the fibers — wool, for instance — slip past each other, and their toothed edges interlock, so that a continuation of the process causes them to be more and more intimately associated, huddling together and holding tight.

The cloth is folded or rolled, and treated with soapy water. It is then beaten with wooden stocks or mallets, by which the serrated edges are forced past each other and the fibers closely commingled. Precautions are taken in some cases to prevent adherence of the folds of cloth by felting together. For this purpose cotton cloth may intervene between the folds of woolen cloth in the roll. It is usually folded, however.

Fulling and felting are dependent upon the same principle of action. Felted cloth is made by this process of associating the fibers, and is not woven. Woven cloth exposed to the fulling or felting action is said to be *milled*. Repetition of the process constitutes it *double-milled* or *treble-milled*, as the case may be. Each milling thickens and solidifies it, while diminishing the area.

In a tomb at Beni Hassan about the time of Osirtasen, who was probably the Pharoah that invited Jacob to Egypt and settled him in Goshen, we find a representation of the fulling process (shown at *a*, Fig. 2125). The roll of cloth is wetted and worked between a block and the inclined table, the water running into a trough below.

After this record of the eighteenth century B. C., it is easy to discredit the statement of Pliny that the art of scouring and fulling cloth and woolen stuffs was invented by Nicras, the son of Hermias, who was a governor of Megæra under Augustus. The Romans worked the cloth with lye and fuller's earth, then washed it in a decoction of saponaceous plants, and then bleached it by fumigation with sulphur.

The instruments of the fuller are mentioned by the Greek authors. One form is a pounder, and the other a wooden roller.

The operations of fulling are shown in the paintings on the walls of Pompeii. At that time the fullers were also the washers of ordinary clothes.

"The largest and best executed paintings representative of the art were discovered in 1820, in the house of a fuller opening on one side on the street of Mercury, and on the other on a street called after

him, Fullonica. In the court, a pillar covered with pictures was standing alongside a fountain. This pillar has been removed and deposited in the Naples Museum. In the lowest division, a woman, sitting, hands a piece of cloth to a little female slave. A workman, whose tunic is closely tied around the body, is looking at them while at the same time carding a white cloak with a purple border, suspended from a stick. Another workman is in the act of sitting down alongside a crate of wicker-work on which the cloth is to be spread out; in one hand he holds a vase, on which sulphur thrown on burning charcoal will develop a gas capable of bleaching the cloth. This is the same method which is used to-day. On another face of the pillar arched niches contain large vats where the goods are soaked. Slaves standing in those vats trample the fabric with their bare feet in the same manner as Arabian women wash their clothes by trampling them against the rocky bed of a stream; this is what the ancients called "the fuller's dance" (*saltus fullonicus*). The artist has painted with the same care the press with its two uprights, its two enormous screws, which were turned by means

Fig. 2125.

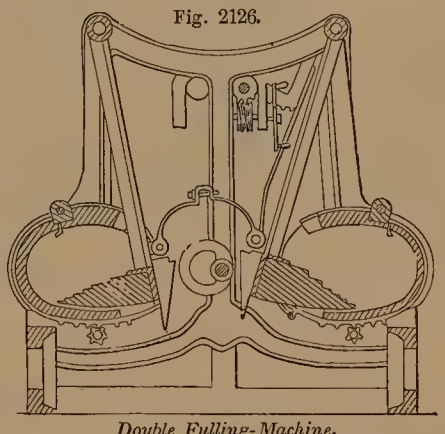
Fulling-Mill.

of cranks, in order to flatten the cloth beneath the planks, which imparted the necessary finish. Finally, the drying-chamber is shown by long sticks hanging on chains from the ceiling. The linen is spread out on them; a slave hands to a young woman an open fabric, while the wife of the fuller makes a note of it on her tablets. I have visited with particular curiosity the houses in Pompeii where these pictures had been gathered. I counted there in a court twenty-two tanks constructed of stone, and at different levels, so that the water could run from one into the other. Little benches in front of them served for the reception of the goods. At the other end of the court, seven smaller tanks served for fulling. The store-room, with traces of the planks, which were laid like rays radiating from a center, the hearths, the drying-chamber, may still be recognized. In other fullers' establishments I have seen very thick sheet-lead lining the interior of vats made of cement. Sometimes, also, we find jars full of greasy earth, which must be the fuller's earth of which Pliny speaks, and which contributed as much to the whiteness of the goods as the fumigation with sulphur." — M. Beulé.

The modern fulling-mill *b* consists of an iron framework supporting the shanks of heavy wooden mallets, which are raised by projecting cams on a tappet wheel. The mallets being raised to their full hight are released, and drop by gravity on the cloth, which is contained in an iron trough beneath. Soap is added as a detergent, grease in any form tending to mar the felting action of the fibers. The end of the trough is curved, so that the cloth is turned round and round by the action of the mallets.

Fig. 2126 is a vertical section of a double mill in which a spring or weight forces the tub up to the

Fig. 2126.

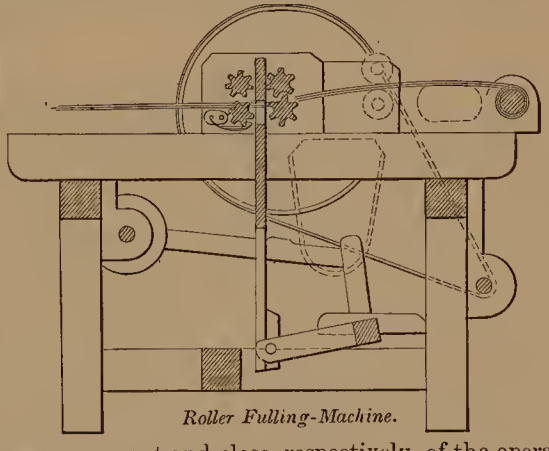


Double Fulling-Machine.

beaters with a yielding pressure, rendering the tub capable of adjusting itself to a larger or smaller quantity of goods. The beaters are arranged in pairs, each pair being connected together by springs and acted upon by a common eccentric.

In Fig. 2127 the felted cloth is held slack between two pairs of fluted rollers while a beater operates upon it. The variation in the velocity of the respective pairs of rollers is equal to the contraction of the cloth, which is damped and dried at the

Fig. 2127.

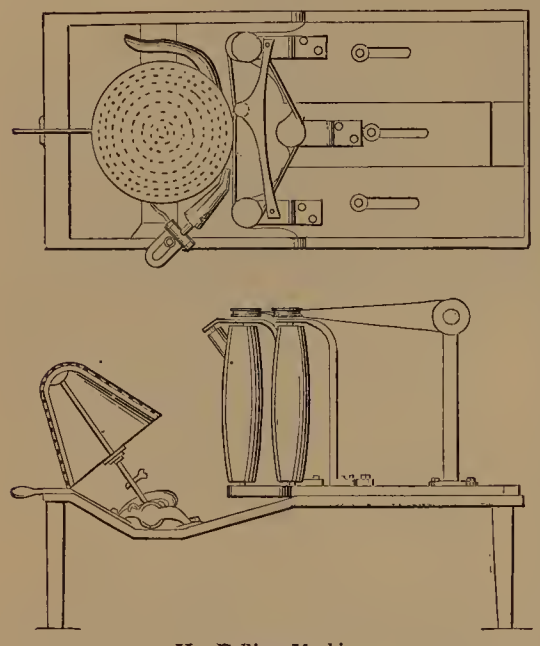


Roller Fulling-Machine.

commencement and close, respectively, of the operation.

Fig. 2128 shows a machine for fulling and felting hat bodies, in which the rollers carry around the apron, which, by contact, rotates the "form," and acts upon every portion of the perimeter of the hat body, the latter being saturated with water, which may be conducted through the tubular support of the form, and be diffused between the walls of the form, so as to escape outward. Owing to the eccentricity of one of the rollers, the apron is repeatedly stretched and relaxed, laterally, and in the act of

Fig. 2128.



Hat Fulling-Machine.

drawing narrower the apron produces a greater pressure upon the hat body, and has the effect to interlock and compact the fibers.

A *broad-cloth* having 3,600 threads in the warp, a width of $3\frac{3}{16}$ yards, and a length of 54 yards, will be reduced in fulling to $1\frac{3}{4}$ yards wide and 40 feet long. The process will take 60 to 65 hours, and require 11 pounds of soap.

A *Venetian* cloth will require about twelve hours, take from 6 to 7 pounds of soap, and will shrink in width from $1\frac{5}{16}$ yards wide to $1\frac{9}{16}$.

After fulling, the cloth is washed to remove the soap.

The method of fulling woolen goods in early times in Ohio is well described by Judge Johnston of Cincinnati, in his address before the Pioneer Society of that city, 1870.

Kicking Blankets.

"When wool became abundant, the method of scouring and fulling blankets, flannels, cassinets, and even cloths, was simple. Every house had hand-cards, and as many spinning-wheels as spinners, and no respectable house was without a loom. When the goods were carded, spun, and woven, then came the kicking frolic. Half a dozen young men, and a corresponding number of young women, "to make the balance true," were invited. The floor was cleared for action, and in the middle was a circle of six stout splint-bottomed chairs, connected by a cord to prevent recoil. On these sat six young men with shoes and stockings off and trousers rolled up above the knee. In the center the goods were placed, wetted with warm soapsuds, and then the kicking commenced by measured steps, driving the bundle of goods round and round; the elderly lady, with a long-necked gourd, pouring on more soapsuds, and every now and then, with spectacles on nose and yardstick in hand, measuring the goods till they were shrunk to the desired width, and then calling the young men to a dead halt.

"Then while the lads put on their hose and shoes, the lasses stript their arms above the elbows, rinsed and wrung out the blanket and flannels, and hung them on the garden fence to dry."

Full'ing-ma-chine'. A machine in which the operation of fulling cloth is performed. See Fulling.

Full'ing-mill. A common name for the fulling-machine. See Fulling.

Ful'mi-nate. Beckman states that fulminate of gold was discovered by a monk in the fifteenth century. This substance, which explodes more rapidly and with greater local force than gunpowder, is made by precipitating a solution of chloride of gold by an excess of ammonia. Mr. Forsyth discovered that by treating mercury as the old monk had treated gold, an equally powerful but far less expensive fulminate might be made. This he mixed with six times its weight of niter, and the result is the percussion-powder which, in the form of paste, is used for charging copper caps for fire-arms. In modern practice the proportion of niter has been much reduced.

"Dr. Allen tells me that something made of gold, which they call in chymistry *Aurum Fulminans*, a grain, I think he said, of it, put into a silver spoon and fired, will give a blow like a musquett, and strike a hole through the silver spoon." — Pepys, 1663.

A fulminating powder which explodes when heated to 360° may be made of niter, 3 parts; dry carbonate of potash, 2 parts; sulphur, 1 part.

The following patents may be consulted by those desirous of ascertaining the ingredients of various patented fulminates: —

Guthrie .	1834.	Boldt . .	1866.
Kling .	1857.	Rand .	1867.
Ruschaupt *et al.*	1862.	Goldmark .	1867.
Lipps .	1864.	Ruschaupt	1868.
Stockwell .	1865.		

Fu'mi-ga'tor. An apparatus for applying smoke, gas, or perfume: —

1. To destroy insects or vermin in their holes, or upon clothing, trees, or plants.

2. To destroy infection or miasma in buildings, ships, clothing, or feathers.

3. To diffuse a fragrant or invigorating perfume through an apartment or ward.

4. To suffuse the lungs with a soothing or healing vapor.

The fumigator involves the use of heat, and generally that of an artificial blast.

1. A fumigator for expelling or killing animals usually consists of a chamber in which burning matters are placed, and a bellows by which a blast of air is driven through the retort, issuing with the fumes at a nozzle directed to the burrow or haunts of the vermin.

Sometimes powder is substituted for fumes.

2. Fumigators for destroying infection are sometimes only agents for making a stench which overpowers the precedent nuisance. The burning of tobacco, feathers, leather, brown paper, etc., will conceal, but does not remove, an unwholesome smell. More potent agents, such as pastiles, pepper, hot vinegar, etc., have been used as disinfectants with but small effect.

The effective agents in fumigating are sulphurous acid gas, chlorine, tar, roasting coffee, etc.

The ordinary disinfectant is chlorine, either in the form of chloride of lime or in the direct evolution of gas from a mixture of salt, manganese, suphuric acid, and water.

This was the plan adopted by Faraday in the disinfecting of a penitentiary in London. The space being about 2,000,000 cubic feet, he used 700 pounds of common salt and the same quantity of

black oxide of manganese. The mixture was set about in numerous pans throughout the wards and corridors. Three and a half pounds of a mixture of salt and manganese were placed in a pan, and on them was poured 4½ pounds of dilute acid. (Sulphuric acid, 2; water, 1.)

3. The perfuming fumigator is generally of the form of an ATOMIZER (which see).

4. As applied to the mouth it is an INHALER (which see).

Fum'ing-box. (*Photography.*) In printing photographically, the sensitive paper, having chloride and nitrate of silver upon its surface, is exposed to the fumes of ammonia immediately before its exposure to light under the negative; the object being to secure greater depth and brilliancy in the resulting print. The apparatus for this purpose is simply a tight box, in which the sensitive sheets can hang, leaving a space below them for a flat basin containing ammonia. Boxes of this kind are variously constructed, the object in all cases being to admit of the ready introduction and removal of the sheets, as well as of the vessel containing ammonia, without subjecting the operator to unnecessary annoyance from the fumes.

Fu-nic'u-lar-ma-chine'. One actuated by means of a cord whose ends are attached to two objects and which bears a weight suspended from the bight. Some double-toggle presses come within the terms of this description. The name is principally applied to instruments illustrative of mechanical principles, and having a rope, pulley, and suspended weights.

Fun'nel. 1. The chimney of a steamship. It is of sheet-iron, and is carried to a sufficient hight to assist the draft of the furnace.

It is made telescopic in war-vessels, so as to be lowered beyond the reach of shot.

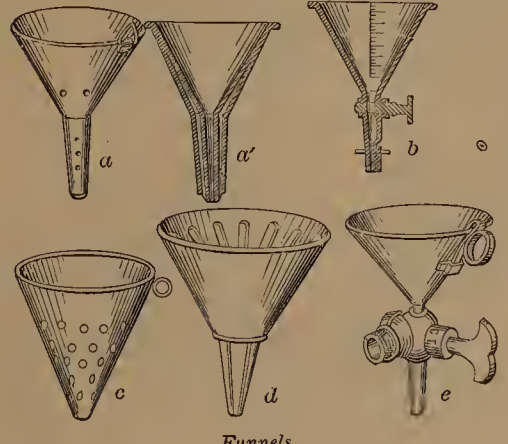
2. The pouring-hole of a mold. A *gate;* a *tedge.*

3. A conical vessel which terminates below in a spout, and used for conducting a liquid into a vessel which has a small opening.

An implement with a wide mouth and tapering spout, used for conducting liquids into a narrow-throated vessel.

a a' are elevations and sections of a funnel, which

Fig 2129.



Funnels.

has a discharge around the spout for the air displaced by the liquid.

b is a graduated funnel, which indicates the quantity of the contents. See MEASURING-FUNNEL.

c is a pierced filter of porcelain or glass, used in a laboratory, with a cone of bibulous paper inside.

d is a filter of similar use, but with heavy ridges, to keep the paper from adhering to the sides.

e is a combined measure, faucet, and funnel.

The filter-funnel should have sides which subtend an angle of 60°, for the reason that a sheet of bibulous paper, folded quarterly and one flap opened, forms a cone the vertical section of which is a triangle with sides forming that angle.

Fun'ny. (*Nautical.*) A narrow, clinker-built pleasure-boat, to be rowed by a pair of sculls.

Fuor. (*Carpentry.*) A piece nailed upon a rafter to strengthen it when decayed.

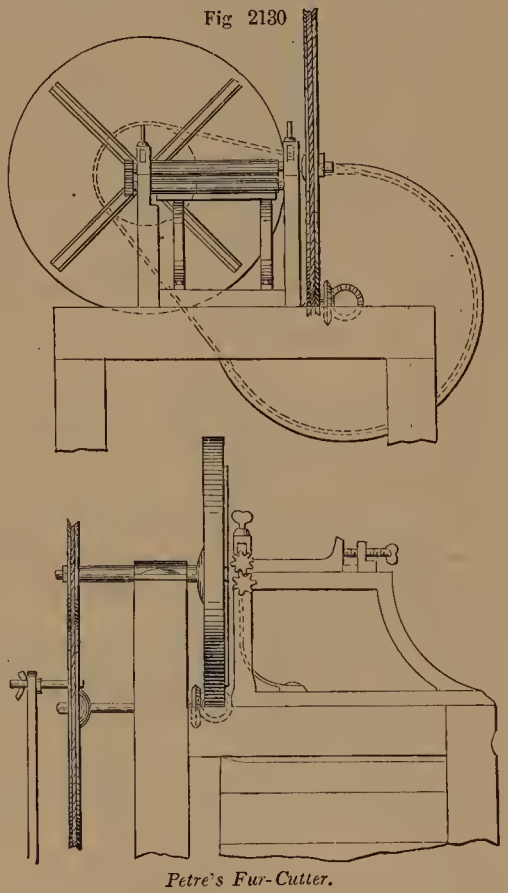
Fur'bish-er. A *burnisher.*

Fur-cut'ter. 1. A machine for cutting the fur from the skin.

Johnson, 1837, has a knife hinged at the end, and descending to make a shear cut against a stationary blade. The skin passes over a small roller, which displays the fur and enables the knife to reach the hairs near the roots, without to any great extent cutting to waste or cutting the same hairs twice.

Petre, 1827, has a pair of rollers, between which the skin passes. As the skin is bent over one of the rollers, the hairs are displayed and thus laid over a straight edge. The knives are fixed radially to a rotating disk, and shear past the straight-edge, sev-

Fig 2130



Petre's Fur-Cutter.

ering the hairs with nearness to the skin determined by the *set* of the machine.

Williams, 1832, has a frame with a series of parallel knife-edges presented upwardly. Over them is a block carrying an oblique knife which makes a shear cut upon the fixed knives in succession.

Flint's fur-cutting knife, 1837, has an edge on one jaw and a cushion on the other.

See also Harlow's patent for cutting bristles, 1868.

2. A mechanical contrivance for shaving the backs

of peltry skins, to loosen the long, deeply rooted hairs, leaving the fine fur undisturbed.

Fur-dress'ing. Fur, in its usual trade acccptation, is the short, fine hair of certain animals, growing thick on the skin and deprived of the long, coarse, protecting hairs.

Furs are dressed by greasing and tramping, or by beating in a fulling-mill, the skin being softened by the absorption of grease and the mechanical treatment. They are then wetted, fleshed, curried, tramped in vats with sawdust, and again with whitening to remove the grease. They are then beaten with a stick and combed.

The term *dressing* includes the cleaning, cutting, and dyeing of furs. The long hair that covers the fur is removed by a process carried on in but few places successfully. The skins are placed on frames, and the inner surfacc pared off, until the roots of the *hair* are completely severed, while the roots of the *fur* remain untouched, on account of their nearness to the outside surface. The hair is then very easily removed, and the light yellow fur made ready for dyeing, either to a more golden yellow, a dark purple, or black, and is afterwards brought to the general fur-market.

In one process, the hair and skin are separated and a substitute for the skin applied to roots of the hair to retain them. Gelatine is applied in solution to the hair, so as to form, when cool, a body to hold the hair in position during the removal of the natural skin and the application of a substitute to the roots. The hair and natural skin are loosened by soaking in lime-water or other suitable means. The artificial skin may be formed of india-rubber, gutta-percha, or compounds thereof, boiled or drying oil, or other adhesive matters, strengthened, if desired, by woven fabrics, and when applied and set, the glutinous matter employed as temporary holding medium may be removed by dissolving in warm water or steam.

Furl. (*Nautical.*) To roll a sail and confine it to the yard.

The sail being gathered by the men on the yard, the *leech* is passed along the yard to the *bunt*, where the body of the sail, the *foot* and *clews*, are collected.

Cunningham's patent (English) mode of setting and furling sails is, by rolling the yard by means of ropes from the deck, unwinding or winding the sail, as the casc may be. The plan involves a vertical division of the sail, and has not come into general use.

Furl'ing. The wrapping or rolling of a sail on a yard or boom and securing it.

Fur'nace. A chamber in which fuel is burned for the production of heat, which is directed upon an object in the vicinity, such as an ore or metal under treatment, a steam-boiler, an air-heating chamber, a glass-pot, or what not.

Furnaces are distinguished by construction, by mode of operation, and by purpose. See under the following heads: —

Air-furnace.
Air-heating furnace.
Almond-furnace.
Aludel-furnace.
Annealing-arch.
Annealing-furnace.
Antimony-furnace.
Arsenic-furnace.
Ash-furnace.
Asphaltum-furnace.
Assay-furnace.
Athanor.
Balling-furnace.
Bar-heating furnace.
Bath-furnace.
Bead-furnace.
Biscayan-forge.
Bismuth-furnacc.
Blast-furnace.
Blomary-furnace.
Blowing-furnace.
Boiler-furnace.
Boiling-furnace.
Bone-black furnace.
Bottoming-hole.
Brass-furnace.
Brick-kiln.
Burning-house.
Calcar.
Calcining-furnace.
Carbonizing-furnace.
Carquaise.
Car-wheel furnacc.
Castilian-furnace.
Cast-steel furnace.
Catalan-furnace.
Cementing-furnace.
Chaffer.
Charcoal-furnace.
Charcoal-kiln.
Chaufer.
Chemical-furnace.
Coke-furnace.
Coke-oven.
Converting-furnace.
Copper-furnace.
Cupello.
Cupola-furnace.
Decarbonizing-furnace.
Dental-furnace.
Desulphurizing-furnace.
Draw-kiln.
Dumb-furnace.
Dust-fuel furnace.
Enameling-furnace.
Enamel-kiln.
Engine-furnace.
Evaporating-furnace.
Finery-furnace.
Fire-back.
Fire-bar.
Fire-door.
Flashing-furnace.
Flatting-furnace.
Foge.
Forge.
Fritting-furnace.
Fruit-dryer.
Fuel-feeder.
Gallery-furnace.
Gas-furnace.
Gas-heated furnace.
Gas-reverberatory furnacc.
Glass-furnace.
Glass-annealing furnace.
Glaze-kiln.
Glory-hole.
Glost-oven.
Gold or silver furnace.
Grain-dryer.
Gypsum-furnace.
Hardening-kiln.
Haymaking-furnace.
Heating-furnace.
Hot-air furnace.
Hot-blast furnace.
Hydro-carbon furnace.
Iron-furnace.
Kiln.
Kiln-dryer.
Lamp-black furnace.
Lead-furnace.
Leer.
Lime-kiln.
Liquidation-furnace.
Liquid-carbon furnace.
Locomotive-furnace.
Lumber-kiln.
Malleable-iron furnace.
Malt-kiln.
Mercury-furnace.
Muffle-furnace.
Nitric-acid furnace.
Nose-hole.
Oast.
Ore-calcining furnace.
Ore-roasting furnace.
Ore-smelting furnace.
Oven.
Oxidizing-furnace.
Peat-burning furnace.
Petroleum-furnace.
Portable-furnace.
Pottery-kiln.
Puddling-furnace.
Quicksilver-furnace.
Reducing-furnace.
Refining-furnace.
Regenerating-furnace.
Reheating-furnace.
Reverberating-furnace.
Riveting-hearth.
Roasting-furnace.
Salt-furnace.
Silver-furnace.
Slag-furnace.
Slip-kiln.
Smelting-furnace.
Smoke-consuming furnace.
Soldering-furnace.
Spreading-furnace.
Steam-boiler furnace.
Steel-furnace.
Stück-furnace.
Sugar-furnace.
Sulphur-furnace.
Sweating-furnace.
Test-furnace.
Tile-kiln.
Tin-furnace.
Upsetting-furnace.
Vulcanizer.
Welding-furnace.
Wind-furnace.
Wrought-iron furnace.
Zinc-furnace.

Fur'nace-bridge. A barrier of fire-bricks or of iron plates containing water thrown across the furnace at the extreme end of the fire-bars, to prevent the fuel being carried into the flues, and to quicken the draft by contracting the area.

Fur'nace-grate. The bars supporting the fuel in a furnace. See GRATE.

Fur'nace-hoist. An elevator for raising the ore, lime, and coal to the month of a blast-furnace. These are of several different forms; the example shown is on the pneumatic principle. It consists of a central tube *a* in which is a heavy piston *b*,

which forms a counterweight for the platform *c*, which works against guides on the outside of the tube. The piston is lightly packed by cotton gaskets, and is connected to the platform by four wire-ropes, two of which only appear in the vertical sectional view.

The hoist is worked by an engine with a pair of inclined cylinders, operating a pair of single-acting air-pumps, which can be made to compress air into or exhaust air from the space in the tube below the piston. Supposing the empty table with the empty barrows to be at the top, and the piston at the bottom of the cylinder, the air-pumps are connected with the latter so as to deliver air into it, and thus lift the piston, a pressure of about two pounds per square inch being sufficient to do this. On the other hand, if the table is at the bottom of its travel and loaded, the exhausting side of the air-pump is, by means of the reversing slide, placed in communication with the cylinder, and a partial vacuum produced under the piston. If the table be loaded with the heavy iron-stone wagons, carrying about 5,000 pounds of stone, there is a weight of about 4,000 pounds left unbalanced, and exhaustion of about 4 pounds per square inch is required to bring the piston down, while, with the coke-barrows, weighing only 2,000 pounds, there is but about 1,000 pounds of unbalanced load, and the piston is brought down and the table raised by a vacuum of about one pound only.

Fur'ni-ture. 1. (*Nautical.*) The masts and rigging of a ship.

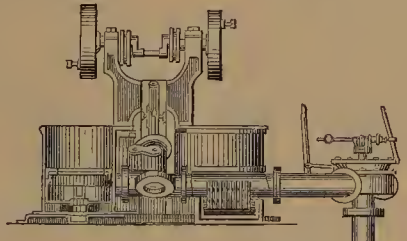
2. The mountings of a gun.

3. Builders' hardware, such as locks, door and window trimmings, etc.

4. Movable articles of use and decoration in a house.

The ancient Egyptians excelled in furniture, chairs with arms and backs magnificently upholstered, with seats like our rush-bottoms, or folding like our camp-stools.

Their bedsteads were couches, generally designed for one person, and variously ornamented. Some have legs representing those of men or of dogs, the bed portion being a ridiculously attenuated body to correspond. See CHAIR; BEDSTEAD, etc.



Their tables were round, square, oblong; of wood, stone, metal; carved, painted, gilded; with a central column or with several legs.

5. (*Printing.*) The wooden inclosing strips and *quoins* which surround the *matter* in the *chase*.

The pieces are about half an inch high, of various lengths. The strips are called *head*, *foot*, or *side sticks*, according to their position in the *chase*.

Strips between the pages are *gutters*.

The *sticks* are slightly tapering, so as to allow the wedge-shaped *quoins* to jam the matter firmly together in the *chase*.

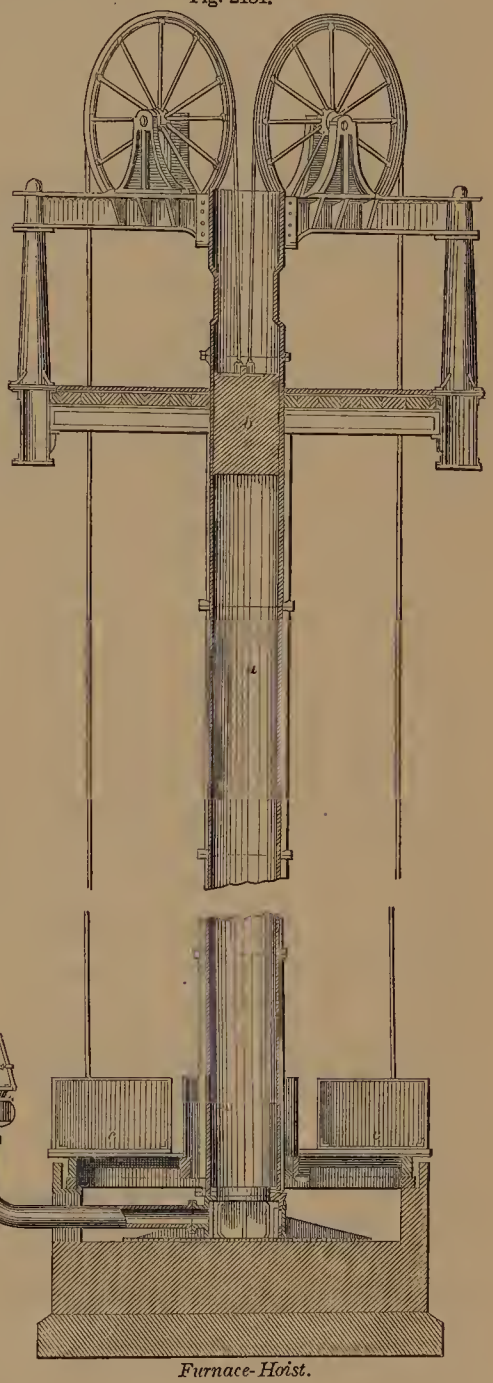
The *quoins* are driven by the *shooting-stick* and a mallet.

Fur'ni-ture-pad. A piece of india-rubber or similar thing attached to a piece of furniture to prevent rubbing or striking against objects.

Fur'ni-ture-spring. A coiled spring beneath the hair filling which forms the seat, back, or side of a cushioned chair. A spring of a bed-bottom beneath a mattress, or forming the lower portion of one beneath the elastic material which constitutes the top.

Fur'ni-ture-tip. An india-rubber disk placed on the foot of a chair-leg, to enable the chair to be moved and replaced noiselessly upon bare boards or marble floors.

Fig. 2131.



Furnace-Hoist.

Fur-pull'er. The fine fur of fur-bearing animals is protected by a coat of long, straight hairs, which is removed before the fine hair is sheared off to furnish the material for felt.

This operation, formerly effected by hand, is now performed by machines. The skin is passed around the projecting edge of a bed, the tension of the skin being maintained by weights. As the skin is drawn forward over the projecting edge of the bed, the long hairs stand out nearly at right angles, and are seized

and extracted by ribs on a pair of revolving cylinders which are placed in front of the bed.

Graham's machine, 1835, passes the skin between two feed-rollers over a third higher roller, which spreads the hairs, which are pinched between a revolving blade and the elastic surface of a leather-covered cylinder, and so pulled out of the skin, which is stretched and fed by two pairs of rollers between which it passes.

Fur'ring. 1. Fixed thin pieces on the edge of timber to make the surface even.

2. Double planking of a ship's side.

3. The scaly deposit on the inside of a boiler.

4. A lining of scantling and plaster-work on a brick wall, to prevent the dampness of the latter reaching the room.

Fur'row. 1. (*Agriculture.*) The trench made by a plow.

2. (*Milling.*) The grooves in the face of a mill-stone; the plane surface is *land*.

A *leader-furrow* extends from the eye to the skirt of the stone at such *draft* as may be determined. The draft is the degree of deflection from a radial direction. In a seven-inch draft the track edges are tangential to a seven-inch circle around the eye of the stone. The steep edge of the furrow is called the *track*-edge; the more inclined edge is called the *feather*-edge.

The *second furrow* is that branching from the leader nearest to the eye.

The *skirt-furrow* departs from the leader nearer to the skirt.

A *gouge-furrow* is concave at bottom. See MILL-STONE.

Fur'row-ing-ham'mer. A mill-stone dresser's hammer. See MILL-STONE HAMMER.

Fur'row-ing-plow. One with a double mold-board for throwing the earth both ways.

Fu'sa-role. (*Architecture.*) A molding or ornament placed immediately under the echinus in the Doric, Ionic, and composite capitals.

Fuse. A tube or casing filled with combustible material, and used for igniting a charge in a mine or hollow projectile.

The invention was undoubtedly contemporaneous with that of hollow projectiles.

Blasting-fuse; used in mining and quarrying is filled with a slow-burning composition, allowing time for the operatives to reach a place of safety before it burns down to the charge.

Combination-fuse; for hollow projectiles, comprises a time-fuse and a percussion or concussion-fuse united in the same case.

The former is designed to explode the charge in case the latter fails to act on striking.

Concussion-fuse; for hollow projectiles. Designed to explode the charge when the shell strikes an object.

Electric-fuse. One adapted to be ignited by the passage of an electric spark through it.

Percussion-fuse; embraces a capsule charged with fulminate, which is exploded by a plunger or its equivalent, when the projectile strikes. The plunger is held by a pin sufficiently strong to keep it in place in case of a fall, yet weak enough to be severed by the shock of striking.

Safety-fuse; a cord or ribbon-shaped fuse filled with a fulminating or quick-burning composition, and sufficiently long to be ignited at a safe distance from the chamber where the charge is placed.

Tape-fuse; belongs to the class just mentioned, and is so called from its shape.

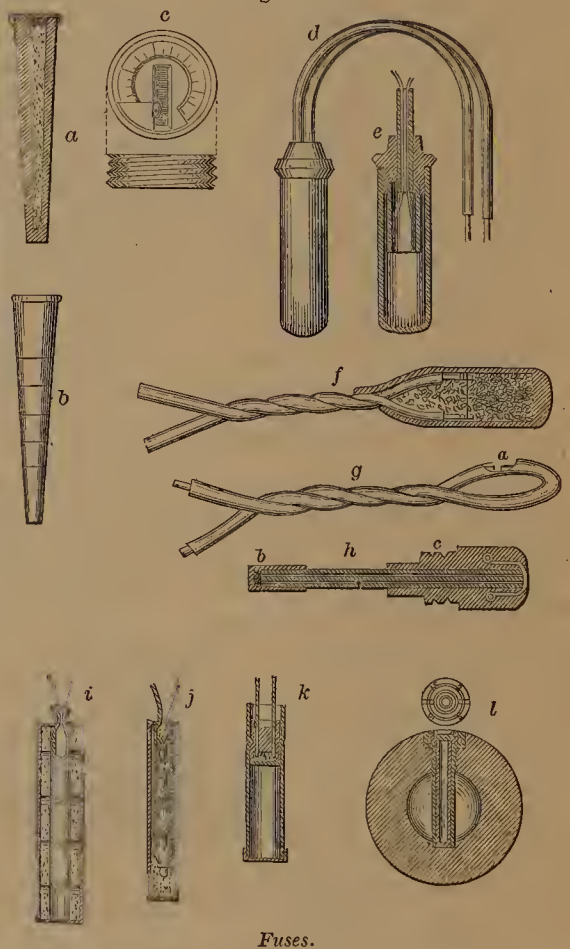
Time-fuse; one which is adapted either by cutting off a portion of its length or by the character of its composition to burn a certain definite time.

Fig. 2132, *a b* is the common wooden fuse for shells; the central cavity is filled with a composition of niter sulphur and mealed powder thoroughly incorporated together, and uniformly and compactly driven by means of a mallet and drift. The open end is capped with water-proof paper or parchment.

For use, a part is sawed off at the smaller end. The number of seconds which the remaining composition will burn is indicated by the annular lines, so that cutting off a greater or less portion regulates the time of bursting of the shell. The fuse is inserted in the fuse-hole when the projectile is required for use, and the cap removed previous to loading the piece.

Paper fuses containing compositions which burned at the rate of two, three, four, and five seconds to

Fig. 2132.



Fuses.

the inch were formerly employed for field artillery in the United States service. A wooden fuse-plug was driven into the projectile when prepared for service, and the fuse inserted therein at the moment of loading. The different kinds were indicated by their color.

These were succeeded by the Bormann fuse *c*, which consists of a flat, circular, screw-threaded piece of an alloy composed of equal parts of tin and lead, having a deep annular channel extending nearly around its lower surface, into which the fuse composition is pressed, communicating with a magazine of fine powder. The composition is protected by an annular piece of the same metal, which is forced down over it by pressure, and turned to a smooth surface. The upper part of the fuse is graduated to quarter-seconds up to five seconds, so

that by removing the thin metal covering with a small gouge at any particular mark, the composition, when ignited, will burn the length of time that the mark indicates before reaching the magazine which communicates fire to the bursting charge of the projectile. This fuse rests in part on the walls of the shell and in part on a perforated iron fuse-plug, set in a smaller orifice central to the exterior fuse-hole. When screwed in, it is cemented to the shell by white lead ground in oil, rendering its extraction somewhat difficult and dangerous. To obviate this a modification has been contrived consisting of a flat ring which contains the composition inserted into an annular groove surrounding the hole through which powder is poured into the shell. As this may be made smaller than the ordinary fuse-hole, the efficacy of the bursting charge for shattering the shell is increased, while the charge may be removed without disturbing the fuse; thus greatly lessening the danger of accidents, when it is desired to remove the powder. This form also admits of longer burning fuses than the original Bormann.

Brass fuses having a crooked channel to prevent the entrance of water between the exterior priming and the fuse composition are also employed, more particularly in the naval service.

The English Boxer fuse has a main channel for the fuse-composition, and two smaller channels filled with mealed powder communicating therewith and with each other. Holes corresponding to the lengths required to burn various times are bored from the exterior of the fuse-case to these, and filled with pipe-clay, which is removed from the proper hole when the projectile is inserted into the gun.

Powel's fuse *l* (Fig. 2132) admits of being turned within the plug, which is screwed into the shell so as to bring corresponding apertures in the fuse and the plug into communication. These are so adjusted to each other that the composition may be made to fire the bursting charge at the expiration of a greater or less number of seconds.

Fuses on this principle have been combined with the percussion-fuse, constituting the *combination* fuse.

Previous to the introduction of rifled cannon and elongated projectiles, a number of attempts had been made to produce a fuse adapted to spherical projectiles which would explode on striking.

One of these, of Prussian origin, was composed of a glass case containing strong sulphuric acid, and wrapped with cotton wick soaked in a composition of chlorate of potash and flowers of sulphur, with pulverized white sugar and alcohol added to give consistency. This was capped with a leaden breaker, which projected beyond a paper case in which the tube and wrapper were enclosed, and the whole inserted within a fuse-case partially filled with hard driven mealed powder. This was ignited on firing, and soon burned away, leaving the glass tube unprotected, so that the weight of the breaker would cause it to be shattered on striking an object, setting fire to the wrapper, which in turn exploded the bursting charge.

Splingard's Belgian concussion fuse contained a conical tube of plaster of paris closed at top surrounded by ordinary fuse-composition, which in burning left the tube unsupported, allowing it to break when striking, so that the fire should communicate directly with the charge.

Fuses which explode by percussion or concussion present no difficulty when employed with elongated projectiles for rifled guns, which strike point foremost; and a variety of such, differing slightly in details of construction, have been successfully employed.

Bickford's fuse, English patent, 1831, was specially intended for miners' use.

It consists of a cylinder of gunpowder or other explosive matter covered by a double layer of cord and varnished. A similar fuse covered with a waterproof composition was designed for submarine blasting.

In electric fuses the heat necessary to fire the charge is imparted either by the passage of the current through a fine wire, usually platinum, or through a chemical mixture rendered conducting by containing a salt of copper. *f* illustrates one of the former, in which the gutta-percha covering is removed from the ends of the conducting wires, which are connected by a fine wire of platinum; these, with the charge of fine grained powder, are enclosed in a water-tight envelope of gutta-percha. *g* is one of the second class, known as Statham's. Its operation depends on the fact that a copper wire covered for some time with vulcanized rubber becomes coated with a layer of sulphide of copper, which is a moderately good electric conductor. This is utilized by twisting a piece of rubber-covered wire so as to form a loop, when part of the covering is removed as shown at *a*, and the wire severed. Consequently, when a spark is passed along the wire, on reaching this spot it must follow the film of sulphide adhering to the rubber; and the resistance which it has to overcome causes the sulphide to ignite.

i j k illustrate Shaffner's blasting fuses and cartridges. *i*, a hollow cartridge provided with central and diverging spaces occupied by a series of fuses and loose nitro-cotton, the whole covered with a water-proof casing into which the ends of the conducting wires pass.

j. The main wires which pass to the mine or cartridge are connected by smaller wires to the fuses, a number of which are placed in a single charge of explosive material.

k is provided with a wooden head enclosed in an indented cylinder closed by a cap; the head has a recess for the fuse composition, and another for the non-conducting cement which surrounds the wires where they enter the head.

h is the Abel fuse. This consists of a wooden head having a central longitudinal opening and two parallel transverse ones. Through the former two insulated conducting wires are passed, the ends *b* of each being cut off smooth at some distance from the head, and covered with a tin-foil cap containing priming. The gutta-percha is removed from the other ends of the wires, and they are inserted and secured in the two transverse holes before mentioned. When required for use, a case containing fine grained powder is fitted over the shoulder *c* and secured by twine.

Bishop's electric fuse *d e* comprises an inner and outer cylinder protected by a perforated cap through which the separately insulated conducting wires pass.

Fuse-cut'ter. An implement for gaging time-fuses to the desired seconds and fractions. The Bormann, or metal-fuse cutter, is merely a small gouge, about one tenth of an inch in width across the blade, and is used for cutting away the thin shell of metal which overlies the fuse-composition. The cutter for paper fuses for rifled guns, which necessarily are required to burn much longer, is more usually called a fuse-gage. It is a block of wood with a graduated brass gage let into one side, and having a hinged knife working on the same side, like a tobacco-knife, by which the fuse, which is

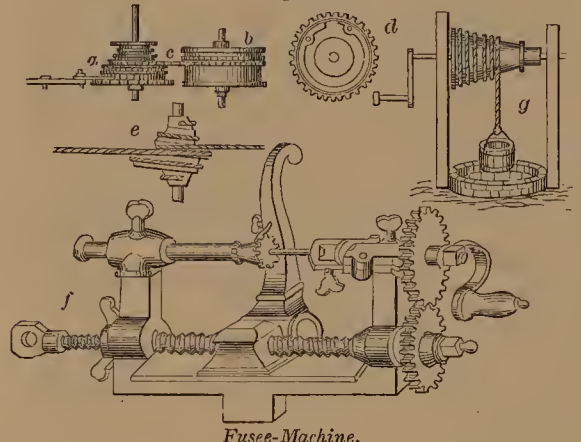
marked on the side to seconds and fractions, is cut off so as to burn any required length of time.

Fu-see'. 1. A conical pulley *a* used in connection with a spring, and designed to equalize the power of the latter. The spring is coiled within the barrel *b*, and when fully wound up and at its greatest tension the chain *c* is wound upon the fusee and draws upon its smaller portion. As the fusee unwinds, by the motion of the train of gearing in the watch, the spring also uncoils and loses a part of its tension; as this proceeds, the chain draws upon a larger portion of the fusee, and attains an increased leverage on the latter to counterbalance the decreased power of the spring. The object is to obtain an equal power at all times, so that the watch may run regularly.

The *first* wheel of a watch is attached to the *fusee*.

The *going-fusee*, invented by Harrison to continue the motion of the watch while it is being wound up, has an auxiliary spring *d* through which the power of the mainspring is communicated to the wheels. While the watch is being wound, a ratchet and click prevent the reaction of the auxiliary spring, which

Fig. 2133



Fusee-Machine.

acts during the time of winding, although the power of the mainspring is removed. The chain connecting the *barrel* and *fusee* has hooks at each end; in winding, the chain is wound off the former on to the latter. The *fusee* cannot be introduced into very flat watches, and the first wheel, in that case, is attached to the *barrel*. The latter is then called a *going-barrel*, having teeth cut on its sides.

A double fusee (*c*) to communicate a variable reciprocating motion is used in Roberts's self-acting mule.

2. A cigar-lighter made of cardboard impregnated with niter and tipped with a composition which ignites by friction.

3. A *fuse*.

4. A light firelock or musket. The name is antiquated. A *fusil*.

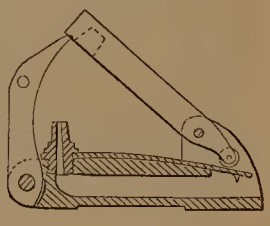
Fu-see'-ma-chine'. A machine (Fig. 2133) for cutting the snail-shaped or spirally grooved wheel on which the chains of certain descriptions of watches are wound. It was invented by the renowned Dr. Hooke about 1655. The machine (*f*) shown is the form that was used in 1741, and illustrates the idea thoroughly. It is also interesting as being the first machine in which *change-wheels* were used, and is the germ of the screw-cutting lathe. — THIRION, 4to, Paris, 1741.

Fu-see'-wind'lass. A pump-windlass with a conical barrel (*g*, Fig. 2133).

Fuse-ex-tract'or. This implement is designed for extracting wooden fuses from shells. It has jaws which grasp the fuse while the lower part of the extractor rests upon the shell. The jaws are attached to a screw, which works in a screw-socket in the body of the extractor, and has an iron lever passing through its head. The jaws being clasped around the projecting part of the fuse, it is drawn by turning the lever.

Fuse-lock. For miners.

Fig. 2134.

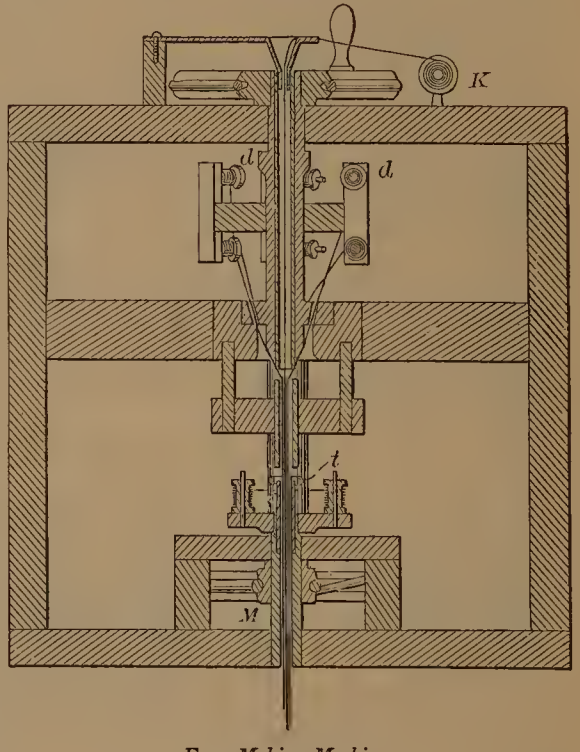


Fuse-Lock.

A spur on the spring attaches the lock to the fuse when the hammer is set. The dog is pulled by a long cord from a distant position of safety, releasing the hammer, which explodes the cap and lights the fuse.

Fuse-mak'ing. A machine having a vertical rotary shaft through which the powder descends around a central cord delivered from the spool *K*. Threads from the spools *d d*, etc., placed on a rotating frame, are wound about it as it descends, forming a twofold covering, which is compacted around the composition as the fuse passes

Fig. 2135.



Fuse-Making Machine.

through the ring *t* at the upper part of the slotted shaft *M*.

Fuse-saw. A tenon-saw used by artillery-men.

Fuse-set'ter. An implement for driving home wooden fuses. It consists merely of a cylinder of wood or brass, with a recess at the end fitting the end of the fuse, which is driven into place by a mallet.

Fuse-tape. A flat form of fuse, coated externally with pitch or tar, and *served* to prevent the coating from cracking, or covered with two warps and an interposed lap of cotton. Other forms might be noticed.

Fu'si-ble-al-loy'. An alloy, usually of lead, tin, and bismuth, compounded in such definite proportions as to melt at a given temperature.

Used as plugs in steam-boilers, so as to melt when

a certain pressure and heat is attained and allow steam to escape. See ALLOY, p. 62.

Fu'si-ble-plug. One placed in the skin of a steam-boiler, so as to be melted and allow the discharge of the contents when a dangerous heat is reached. See "Le Dictionnaire de Industrie, Manufac., Commerc., et Agricole." Par A. Baudrimar. Blanque aîné et antres. Paris, 1833. Vol. 1. p. 326.

Fu'si-ble-por'ce-lain. A silicate of alumina and soda obtained from cryolite and sand, fused and worked as glass.

Cryolite is a mineral consisting of fluoride of aluminium and sodium. It is found in great abundance and purity in Greenland, and serves to make a fine milk-glass, which is called fusible porcelain. It is known in Bohemia and Silesia as milk-glass. One part of cryolite is mixed with two to four parts of quartz or pure sand, thus being a silicate of alumina and soda, containing some fluorine that has not been dissipated during the melting process. The material is easily wrought into any form, and may be readily ground and polished. It is stronger than common glass, and is said to withstand the fire better.

Fu'sil. A light fire-arm or musket of an antiquated pattern.

Fus'ing-points. (Some boiling-points and other data are added for the purpose of comparison.) By P. H. Van der Weyde, M. D.

	Fahr. Degrees.
Platinum; iridium; osmium	3,992
Manganese	3,452
Cobalt	3,272
Melted tin boils	3,092
Pure bar-iron; nickel	2,912
White heat of iron	2,372
Gold; white cast-iron	2,282
Silver	1,832
Copper	1,742
Brass; bronze	1,652
Aluminium	1,562
Full red-heat of iron	1,472
Magnesium	1,382
Cherry-red heat of iron	1,292
Iron, red-hot, visible in daylight	1,112
Iron, red-hot, visible in dark	932
Barium	887
Sulphur boils	842
Antimony melts; cadmium volatilized	797
Tellurium	752
Zinc	707
Mercury and whale-oil boil	662
Lead; cadmium	617
Amber melts; linseed-oil and phosphorus boil	572
Watch-spring temper (deep blue)	554
Sword temper (blue)	536
Knife temper (pink)	518
Steam at 50 atmospheres	509
Bismuth melts; steam at 45 atmospheres	500
Penknife temper (brown yellow)	482
Steam at 34 atmospheres	464
Chisel temper (yellow)	446
Tin melts; steam at 24 atm.	428
Razor temper (straw); steam at 20 atm.	410
Pale yellow temper	382
Steam at 10 atmospheres	356
Camphor	347
Naphtha boils; sulphur ignites	320
Turpentine boils	311
Low vulcanizing temperature	293
Steam at 3 atmospheres	275
Steam at 2 atmospheres	248
Sulphur	230
Water boils	212
Alcohol and benzine boil	176
Stearic acid; white wax	158
Potassium; spermaceti	131
Phosphorus	113
Blood heat	104
Lard	95
Ice melts	32
Mixture of salt and snow	0
Linseed-oil and brandy freeze	−4
Mercury freezes	−40
Liquid ammonia freezes	−49
Carbonic acid freezes	−112
Alcohol (thick as castor-oil) at	−202

For fusing-points of alloys, see p. 62.

Fust. The shaft of a column from the astragal to the capital.

Fus'tian. (*Fabric.*) *a.* A heavy woolen cloth with a napped surface for men's wear.

b. A coarse, thick, twilled cotton stuff for men's wear, and generally of a dark color. The plain, common fustian is specifically known as *pillow*-fustian; other varieties of fustian are known by the names of *corduroy*, *velverett*, *velveteen*, *thicksett*, *double-jean*, *velvet-tuft*, *moleskin* (cropped before dyeing), *beaverteen* (cropped after dyeing), *cantoon*.

These goods were first made in Norwich, England, in 1554, and were called "Norwich satins."

Fut'chel. (*Carriage.*) The jaws between which the hinder end of a tongue is inserted; the similar parts in a wagon are called tongue-hounds.

Fut'tock. (*Shipwrighting.*) One of the timbers in the compound rib of a vessel. A timber of the dimensions and form for the rib of a vessel cannot be procured in one piece; the rib is built up of pieces scarfed together. The number is according to the length of the sections of the requisite hight. They are known as the *first*, *second*, and *third futtock*, terminated by the *top-timber*. See FRAME.

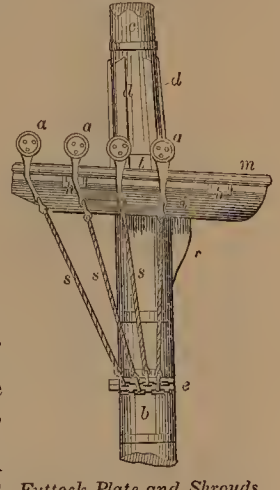
Fut'tock-hoop. (*Nautical.*) A hoop encircling the mast at a point below the head, and serving for the attachment of the shackles of the futtock-shrouds. See Fig. 2136.

Fut'tock-plank. (*Shipbuilding.*) The first plank of the *ceiling* next to the *keelson*. The *limber-strake*. The first plank of the *skin* next to the *keel* is the *garboard-strake*.

Fut'tock-plate. (*Nautical.*) An iron plate on the edge of the *top*, to which the *futtock-shrouds* and the *dead-eyes* of the topmast *shrouds* are secured.

s s, futtock-shrouds.
b, lower mast.
e, futtock-hoop.
a, dead-eyes.
c, topmast.
d, mast-battens.
h, cross-trees.
i, trestle-tree.
m, futtock-plate.
r, cheek or hound.
t, bolster.

Fig 2136.



Futtock Plate and Shrouds.

Fut'tock-shrouds. (*Nautical.*) The short *shrouds* attached to the *chain-necklaces* on the mast, and to the sides of the top, by which ascent is had from the principal shrouds to the top. See Fig. 2136.

Fyke. A bag-net, open to allow fish to enter, but opposing their exit.

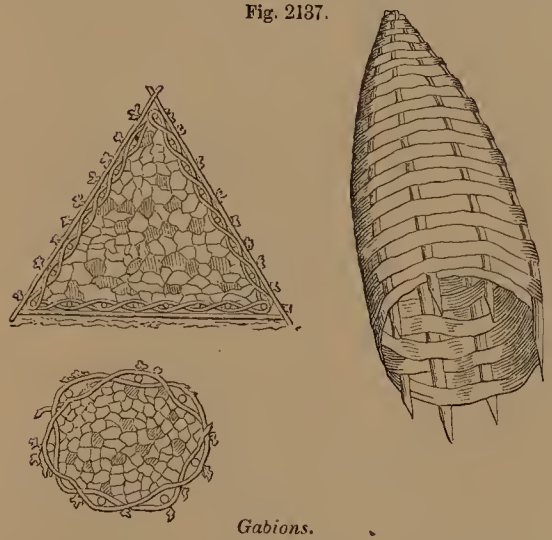
G.

Gab. The hook on an eccentric-rod which engages the wrist on the rock-shaft lever of a valve-motion. The word *gab* means *mouth* in several languages, and the term signifies that it is open to *bite* upon that placed within it. See GAB-LIFTER.

Gab'ar-age. (*Fabric.*) A coarse linen packing-cloth.

Ga'bi-on. A long basket of osiers or withes. When filled with earth, they are adapted to revet

Fig. 2137.



Gabions.

parapets and embrasures of fortifications. They are also used in other earthworks, such as batteries or rifle-pits.

Gabions filled with stones are used in civil engineering as defences for *starlings* of bridges; for making *dikes* or river-walls, where the shore is subject to washing; for making isolated islands, or chains of such, off shore, as a breakwater; also to arrest silt, sand, and mud, and gradually raise the bottom above the level of high-water, in the manner of *groins*.

Military engineers make their gabions about 20 feet long, and 3 feet in girth on the mean, with bands at distances of from 1 foot to 1 foot 6 inches; in Holland the gabions are made from 24 to 27 feet long, from 1 foot 4 inches to 1 foot 8 inches in girth, and with bands at every 6 inches apart; and upon the Upper Rhine the gabions are made from 2 feet 6 inches to 3 feet 4 inches in girth.

Fig. 2138.

Gable.

The gabions of the Greeks, used in forming foundations or making inclined planes for raising architraves of buildings, were baskets of sedge filled with chalk and called *herones*.

Ga'ble. The triangular portion of the end of a building, bounded by the sides of the roof and a line joining the eaves.

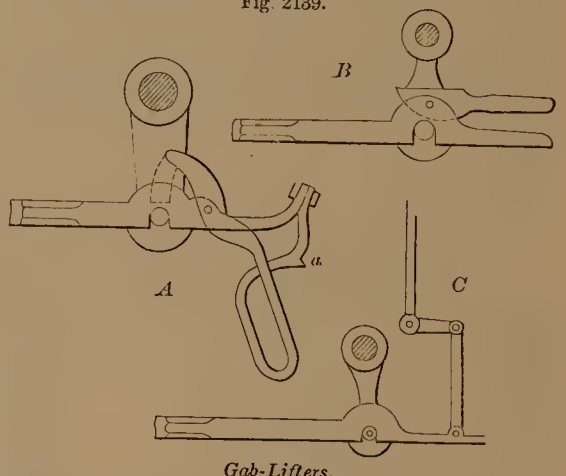
Gable-window; a window in the gable of a house.

Ga'blet. A small ornamental gable or canopy formed over a tabernacle or niche.

Gab-lift'er. A device for lifting the *gab-hook* from the wrist on the crank of the rock-shaft, in order to disconnect the eccentric from the valve-gear. In small engines, the eccentric-rod is simply lifted by means of the handle on the end.

In the apparatus *A*, by pulling up the spring han-

Fig. 2139.



Gab-Lifters.

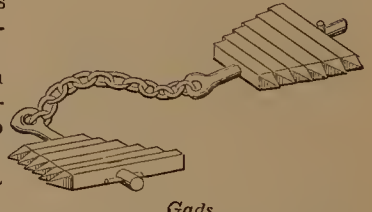
dle below until it catches in the notch *a*, the pin is disengaged from the *gab* on the eccentric-rod.

In *B*, the *gab* is lifted by the oscillation of an eccentric. When the handle of the latter is raised, the eccentric surface bears down on the pin and prics out the *gab-hook*.

In *C*, the operating rod proceeds from above and oscillates a rock-shaft, from which is suspended a link reaching to the eccentric-rod.

Gad. (*Mining.*) *a.* A steel wedge for opening crevices, natural or made by the pick.

Fig. 2140.



Gads.

The figure shows the mode of carrying them.

b. A small iron punch with a wooden handle, used to break up ores.

c. A *jumper;* a boring-bar.

Gaff. 1. (*Nautical.*) The spar which extends the upper edge of fore-and-aft sails, such as the *main*-sail of a cutter, smack, or other one-masted vessel; the *main* and *fore* sails of a schooner, the *spanker* of a ship, the *try*-sails or *spencer* of a brig or ship.

The lower end of the *gaff* has *jaws* which rest against and partially grip the mast. It is supported by the *throat-halyards* at the mast and the *peak-halyards* at the outer end.

The ropes which steady the *gaff* laterally are called *vangs*.

Gaff-sails are bent at the weather-leech to masts, or to *hoops* or *hanks* which run on the mast as the sail is raised or lowered.

2. The metallic spur fastened to the leg of a fighting-cock.

Cock-fighting was a common amusement in England in the twelfth century, and Fitz-Stephen says that it was customary for the schoolmaster to superintend the pit on the usual holiday cock-fighting on Shrove-Tuesday. The English, like the ancient Greeks, armed the heels with spurs. So, after all, our St. Domingo period was not so very long ago.

3. A fish-spear.

Gaff-hook. A heavy, barbed hook with a line, used in landing large fish.

Gaff-top'sail. A sail spread by a gaff above the main-sail of a cutter, or other fore-and-aft rigged vessel.

Gage. 1. An instrument for determining distances, sizes, proportions, as the carpenters' gages of various kinds; sheet-metal and wire gages, which are standards of measurement of thickness; test-gages or templets, by which work in detail is made to an exact set of standards, so that the pieces may be assembled; as the Springfield and other rifles, the Singer and other sewing-machines. There are about seventy-eight gages used for determining and verifying dimensions of the parts in the rifle musket, pattern of 1855; its lock, stock, barrel, ramrod, leaf-sight, bayonet, and mountings.

Whitworth's contrivance for testing the truth of a solid measure representing an English inch is a remarkable specimen of mechanical skill and accuracy. The block representing the inch is a rectangular prism of polished steel, originally cubical, but having its angles so truncated for convenience of manipulation that the terminal surfaces are one quarter inch square. At one of its extremities it abuts against a fixed stop, the other is opposed to the extremity of a screw of twenty threads to the inch, placed directly in the line of the axis. A single revolution of the screw advances the extremity, therefore, one twentieth of an inch. But the head of the screw is ten inches in circumference, and is divided into 200 parts. In turning this wheel, every division accordingly advances the screw one four-thousandth part of an inch. The divisions, however, are not traces, but teeth; and the screw-head is a gear-wheel, which is driven by a tangent screw lying horizontally in its plane and across its summit. And this tangent screw has also a head of $12\frac{1}{2}$ inches in circumference, which is divided into 250 parts, each part being the twentieth of an inch. An entire revolution of the tangent screw advances the gear-wheel only one tooth, which, as we have seen, moves forward the end of the measuring screw one four-thousandth of an inch. A single division of the limb of the tangent screw-head will therefore produce a movement in the direction of measurement of only one two-hundred-and-fiftieth of one four-thousandth of an inch; that is to say, of one one-millionth part of an inch. Between the plane face of the standard inch and the extremity of the measuring screw opposed to it is a little steel plate with parallel and perfectly true surfaces. As the screw advances towards the plate a point is reached where the latter appears to be in contact, but when lifted it will be found to be free, as it will fall freely back, not being held by friction. If now the tangent screw be turned, a single division at a time lifting the plate after each movement, a point will be reached at which a single additional movement of advance will fasten the plate completely, so that the friction will prevent its fall.

Between these points the screw is advanced $\frac{1}{1000000}$ of an inch, and a retraction of the screw to this extent will free the plate so that it will fall; care being taken that disturbance of the equilibrium of temperature shall not change the conditions.

Whitworth's cylinder gages at the Paris Exposition were perforated steel plates, the perforations being highly polished within, and differing from each other in diameter by $\frac{1}{10000}$ of an inch. Corresponding to them were polished steel cylinders, one exactly fitted to each. As these cylinders lie side by side, it would be difficult for the eye to distinguish a difference of diameter between several of them; but when they are tried by the gages, each will pass freely through the aperture corresponding to its own number, but no one can be forced without an effort into one of a higher order. See MEASURING-MACHINE.

2. (*Physics.*) An instrument for determining the condition of a fluctuating object; as a tide, steam, rain, water, wind, current gage, etc. See METER.

3. *a.* The quantity of plaster of paris added to plastering mortar to facilitate setting.

b. Fine mortar with an addition of plaster of paris for a finishing coat.

4. The width of a railway track. See RAILWAY-GAGE.

5. The length of a shingle, slate, or tile which is exposed to the weather. Also called the *margin*. The hidden portion is called the *cover*.

a. Shingles are 18 inches long and expose 6 inches. That is the *gage*. There are thus three thicknesses on a roof.

b. Plain-tiles are $10\frac{1}{2}$ inches long and have a gage of $6\frac{1}{2}$ inches.

c. Pan-tiles are $14\frac{1}{2}$ inches long; gage, 10 inches.

d. Slates vary in length and size. The gage is usually nearly half the length, so that the slates have a little over two thicknesses on the roof.

6. (*Printing.*) A strip of reglet with a notch in it to indicate the length of a page.

7. The depth of immersion of a vessel.

See under the following heads: —

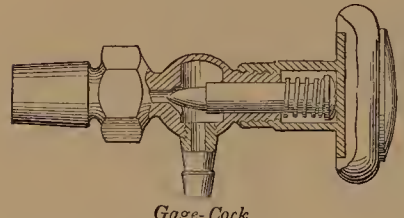
Angle-gage.
Auger-gage.
Axle-gage.
Ball-caliber.
Barometer-gage.
Barrel-gage.
Barrel-filling gage.
Bilge-water gage.
Biseeting-gage.
Boarding-gage.
Boring-gage.
Broad-gage.
Bur-gage.
Caliper-gage.
Carpenter's gage.
Center-gage.
Chamber-gage.
Clapboard-gage.
Coffin-gage.
Condenser-gage.
Counter-gage.
Croze.
Current-gage.
Cutting-gage.
Depth-gage.
Diamond-gage.
Drill-gage.
Electric steam-gage.
Evaporation-gage.
Gage and caliper.
Gage-box for shingles.
Gage-cock.
Gage-concussion.
Gage-dial.
Gaged brick.
Gage-glass.
Gage-ladder.
Gage-lathe.
Gage paper-cutter.
Gage-pile.
Gage-rod.
Gage-saw.
Gage-wheel.
Gaging-caliper.
Gaging-rod.
Gas-fitters' gage.
Gas-gage.
Grain-gage.
Gun-barrel gage.
Hydraulic indicator.
Index-gage.
Joiners' gage.
Knitting-gage.
Liquor-gage.
Marking-gage.
Measuring-apparatus.
Meter (varieties, see METER).
Meter-gage.
Mortise-gage.
Narrow-gage.
Nipper-gage.
Page-gage.
Pear-gage.
Plasterers' gage.
Pressure-gage.

Printers' gage.
Railway-gage.
Rain-gage.
Recording-gage.
Ring-gage.
Rounding-gage.
Router-gage.
Salt-gage.
Saw-gage.
Sawing-machine gage.
Screw-cutting gage.
Screw-thread gage.
Scribing-gage.
Sea-gage.
Setting-gage.
Sewing-machine gage.
Sheet-metal gage.
Shell-gage.
Shingling-gage.
Shingles. Gage-box for
Shot-gage.
Sliding-gage.
Slitting-gage.
Spectacle-gage.
Speed-gage.
Spoke-gage.
Standard-gage.
Star-gage.
Steam-gage.
Stepped-gage.
Surface-gage.
Templet.
Testing-gage.
Thermometric steam-gage.
Tide-gage.
Tool-gage.
Tucking-gage.
Turning-gage.
Vacuum-gage.
Water-gage.
Weather-boarding gage.
Wind-gage.
Wire-gage.

Gage-box for Shin'gles. A box of a certain size in which shingles are laid to form bunches of a certain number. A shingle is about 18 inches long, and every 4 inches of the edge counts as one shingle, so that if it were 12 × 18 inches it would count as 3. The box being 2 feet square, and the tails of the shingles lapping 6 inches, the butts of the layers are presented in alternate directions, each layer counting as six shingles. The box facilitates the counting and bunching.

Gage-cock. (*Steam-engine.*) One of two or more stop-cocks which are screwed into the boiler, one above the level at which water ought to stand in the boiler and the other below it. The ejection of steam and water respectively from the cocks indicates the water-level in the boiler to be between the two gage-cocks. Steam from both shows the water to be too low. Water from both shows the water to be too high.

Fig. 2141.



Gage-Cock.

In the gage-cock shown, the valve is operated in one direction by the tubular cap, and in the other by the steam pressure and a spring.

The *water-gage* is an exterior, vertical tube in connection with the boiler, and in which the water rises to an equal hight.

Gage-con-cus'sion. The rocking laterally of a railway carriage bringing the flanges of the wheels in contact with the edges of the rails.

Gaged-brick. Bricks for arch-building, molded or rubbed to a wedge shape to suit the radius of the soffit.

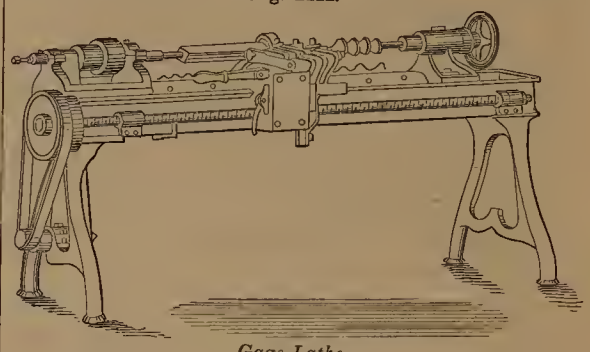
Gage-glass. (*Steam-engine.*) A strong, vertical, glass tube, connected at its ends by two cocks to the boiler, and forming an indicator of the depth of water in the boiler. It is illuminated at night by the *gage-lamp*.

Gage-lad'der. A square timber frame for raising the ends of wheeling planks in excavating. A *horsing-block*.

Gage-lamp. (*Railroad-engine.*) A lantern to throw light on the water-gage of a steam-boiler.

Gage-lathe. One designed to turn out chair-rounds, banister-columns, and all similar objects in which the cylindrical form is modified by contraction or enlargement of diameter, the formation of

Fig. 2142.



Gage-Lathe.

beads, etc., so as to present curves or broken lines in its contour.

The wood is placed between the centers, and is first brought to the form of a regular cylinder by means of a fixed chisel in a slide-rest. The slide-rest has two chisels, one of which reduces the wood to the form of a uniform cylinder, while the other cuts away the portions of the cylinder which must be removed in order to produce the varied outline which the design requires. This latter chisel is in a hinged holder, and a foot firmly connected with it rests on an iron rail or gage, which is cut to the contour which the wood is to have. As the slide-rest advances, this foot rises on the swells and sinks into the depressions of the gage; and the tool-holder, with its tool, rises and sinks with it, and thus transfers to the wood the precise contour of the gage. See NURLED WORK.

Gage Pa'per-cut'ter. A machine having a guillotine-knife descending with a draw-cut upon a pile of paper on a table. An adjustable fence regulates the *gage*, or size. See PAPER-CUTTING MACHINE.

Gage-pile. (*Pile-driving.*) A preliminary pile to mark the desired course.

Gage-rod. A graduated rod, used in measuring the capacity of barrels and casks.

Gage-saw. A saw having an adjustable frame or clamp, which determines the depth of kerf. Used by comb-makers and others.

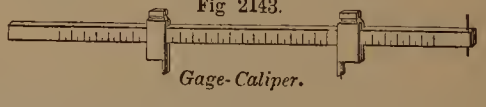
Gage-stuff. A stiff and compact plaster used in making cornices, moldings, etc. It consists of two thirds fine mortar, one third plaster of paris, with a little water.

Gage-wheel. One attached to the forward end of a plow-beam, to gage the depth of furrow.

Gag'ger. (*Founding.*) A T-headed piece of iron with a shank gradually enlarging towards the end, and placed in a mold so as to lock the sand together.

Gag'ing-cal'i-per. A tool in which are combined dividers, inside and outside calipers, and a

Fig 2143.



Gage-Caliper.

graduated double scratch-gage. It is graduated to 16ths, 32ds, and 64ths of an inch.

Gag'ing-rod. An exciseman's or inspector's measuring-staff, for determining the interior dimensions of casks and other vessels holding liquids.

Gag-rein. (*Saddlery.*) A rein which passes over *runners* attached to the throat-latch, so as to draw the bit up into the corners of the horse's mouth when pulled upon.

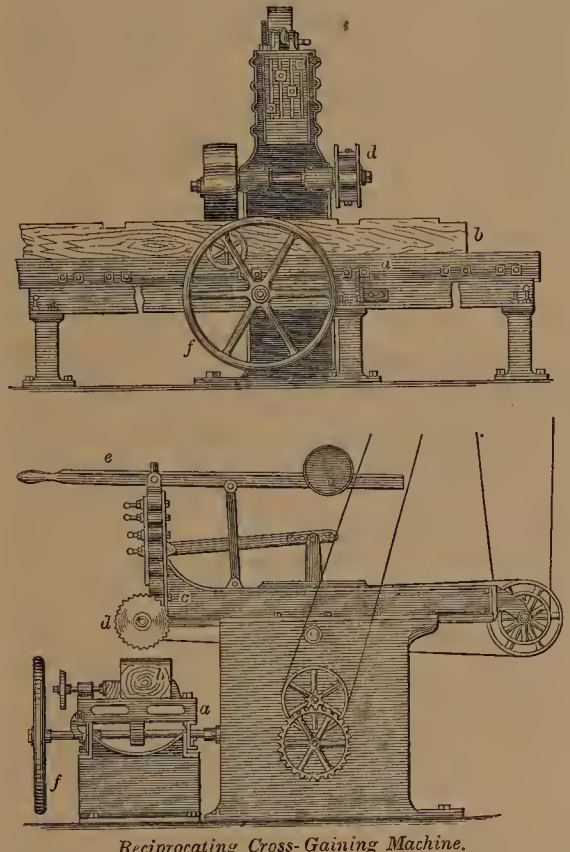
Gag-run'ner. (*Harness.*) A loop depending from the throat-latch; through it the gag-rein passes to the bit.

Gain. A mortise.

A beveled shoulder of a binding joist to strengthen the tenon.

Gain'ing-ma-chine'. A machine for cutting grooves across the face of a beam, usually to receive the shoulder of the tenon, so that the stud joist or post framed into the beam may have a strength to resist lateral strain greater than that due merely to the tenon which rests in the mortise proper. The machine is also adapted for rabbeting and transverse cutting generally. Two circular saws are placed at a distance apart equal to the width of the desired gain. A routing cutter may clear out the chip between the kerfs. The beam *b* is dogged on the bench *a*, and the saw-carriage *c* reciprocates above it, the

Fig. 2144.



Reciprocating Cross-Gaining Machine.

saws *d* being brought down to the work by the counterbalanced lever *e*. *f* is the wheel whereby the beam is moved longitudinally the distance between gains.

Gain'ing-twist. (*Rifling.*) A rifle-groove whose angle of twist becomes greater towards the muzzle. This allows the ball to be more easily started, gaining a greater velocity as it proceeds towards the muzzle. *Increase twist.*

Gai'ter. A covering for the ankle, fitting down upon the shoe. It is usually buttoned or buckled upon the outer side, and has a strap beneath the shank of the shoe.

It is sometimes called a gaiterette, as the term *gaiter* has been colloquially applied to the half-boot with a cloth top, and more recently to all bootees which closely embrace the ankle and the small of the leg immediately above it.

Ga'la. (*Fabric.*) A Scotch cotton fabric.

Gal'a-o-tom'e-ter. An instrument for ascertaining the quality of milk by its specific gravity. A *lactometer*. The former term is founded upon the Greek, and the latter partially from the Latin.

It consists of a stem and bulb, the latter charged with shot serving as ballast, so that it floats upright in the milk, the relative specific gravity being indicated by the centessimally graduated stem.

Gal'e-as. A low-built French galley worked with sails and oars. *Galeasse*, a Venetian galley. *Galiot*, a Dutch galley.

Ga-le'na. Native sulphuret of lead; from *galeo*, to shine.

Gal'ets. The splinters of stone broken off by the stroke of the mason's chisel. Also called *spalls*.

Gal-i-le'an-tel'e-scope. The original form of reflecting telescope used by Galileo. It has a convex, converging object-glass, and a concave, diverging eye-glass. See TELESCOPE.

Gal'i-ot; Gal'li-ott. (*Nautical.*) Formerly, a galley propelled by sails and oars, having one mast and 16 to 20 seats for rowers; used by most of the maritime nations of continental Europe, and called by substantially the same name in the Latinic languages. Now a strong and cumbrous, bluff-bowed, two-masted vessel, used in the Dutch merchant service.

Gal'le-on. A large Spanish vessel with three decks, formerly used.

Gal'ler-y. 1. (*Fortification.*) A covered passage in a work, either for defence or communication. As one beneath the counterscarp and loopholed, or communicating between the enceinte and an outwork.

A gallery in a *scarp* having *embrasures* becomes a *casemate*.

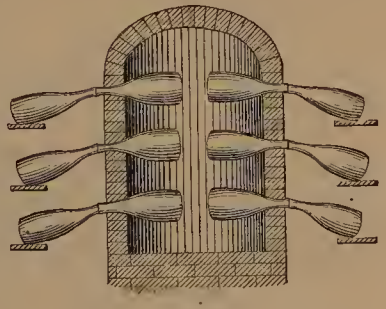
2. (*Nautical.*) A balcony projecting from the after part of a ship, as the *quarter-gallery*, *stern-gallery*.

3. A corridor; a partial story in a room for auditors or musicians.

4. (*Mining.*) An adit or drift in a mine, either as a means of working, of drainage, or of ventilation. The great drainage-gallery of the mines of Clausthal, in the Hartz, is 11,377 yards, equal to 6½ miles long, and passes 300 yards below the church of Clausthal. Its excavation occupied from 1777 to 1800, and cost about $330,000. See ADIT.

Gal'ler-y-fur'nace. A furnace used in the distillation of green vitriol, consisting of a long gallery containing two or three tiers of retorts, 100 in each row. The gallery is a flue traversed by the flame of a fire. The neck of each retort projects through the walls of the gallery and enters an exterior receiver.

Fig. 2145.



Gallery-Furnace.

Gal'ley. 1. (*Nautical.*) *a*. A low, flat-built vessel with one or more rows (*banks*) (see BANK, 5, *a*) of oars, said to have been invented by the Corinthians 700 B. C. The *biremes*, *triremes*, *quinqueremes*, etc., were galleys having so many banks of oars, — two, three, five, etc. The *pentecontori* had fifty oars in a single tier. The *galcasses* of the Venetians had 130 feet keel, 30 feet beam, three masts, thirty banks (see BANK, 5, *b*) of two oars each, each oar manned by six chained slaves. They were intro-

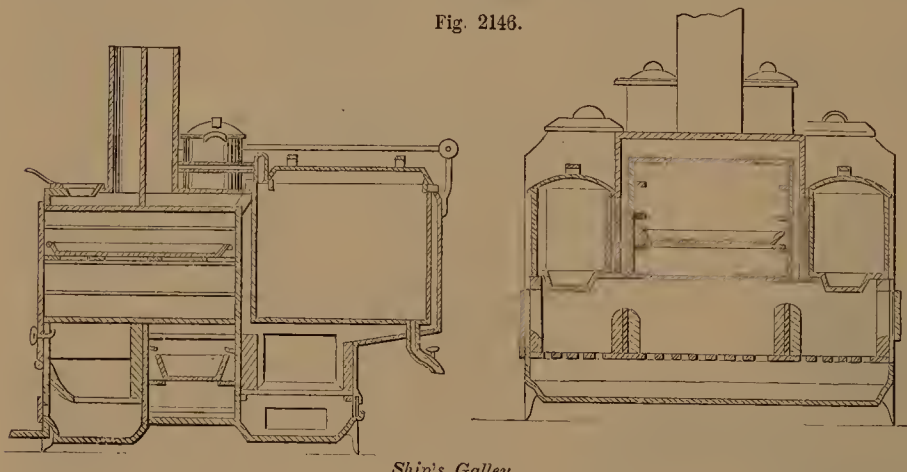
duced into France in the reign of Charles VI., and manned by criminals. He kept forty in his service. They were abolished by Louis XV. in 1748.

b. A clinker-built boat for ship's use, from 28 to 36 feet long, and with a beam equal to .2 of its length. It is a light, sharp boat, carrying from ten to twelve oars, and is used for speedy rowing on expeditions. It usually has six alternate oars rowed by a picked crew.

c. The cook-house on board ship which is on deck, or in a forward part of the vessel.

In the example, the caboose has three grates in front so arranged that one or all may be used at a time, and a rear grate, over which are three large boilers. Over a central front grate is a large oven, and between the front and rear fires is another; the products of combustion from the front fires circulate up around and over the front oven, on top of which are apertures for cooking-vessels; boilers may be placed over the side fires; and, on the top of the stove, boilers or cooking-vessels may be used. Pipes from the top of the large boilers convey the steam arising in cooking to the smoke-flue. Convenient arrangements are provided for the draft and for removal of ashes. The smoke-flue is so divided by a central partition as to give separate passages from the front and rear fires.

Fig. 2146.



Ship's Galley.

2. (*Printing.*) An oblong tray which receives matter from the composing-stick, and on which it is arranged in a column or page. The galley has a ledge on both sides and at top, half an inch in hight. From this it is taken to the imposing-stone and arranged in a chase. The galley sometimes has a groove to admit a false bottom, called a *galley-slice*.

Fig. 2147.

Printers' Galley.

In that illustrated the space for the matter is adjustable in width by a straight *side-stick* and thumb-screws, so as to *lock up* the *matter*.

Gal'ley-roll'er. (*Printing.*) A short inking-roller for taking *slip* proofs of matter in galley.

Gal'ley-slice. (*Printing.*) A sliding false bottom of a galley. See GALLEY.

Gal'ley-stick. (*Printing.*) A long tapering stick less than type high, which is placed beside a column of type in a galley, and the whole *locked up* or wedged in place by *quoins*.

Gal'li-vat. A large East Indian rowing-boat.

Gall of Glass. Scum of melted glass. *Sandiver.*

Gal-loon'. (*Fabric.*) A narrow cotton fabric used for binding shoes, etc.

A narrow binding stuff with threads of gold and silver. A silk, woolen, or mixed tape for edging, binding, or shoe-strings.

Gal'lows. 1. (*Husbandry.*) The central core of four corn-stalks interlaced diagonally, and bound at the intersection, forming a *stool* or support for cut corn, which is bound around it to form a *shock*.

2. (*Printing.*) The rest for the tympan when open.

3. The frame supporting the beam of a steam-engine.

4. A frame on which criminals are hanged.

Gal'lows-bitts. (*Nautical.*) A strong frame erected amidships on the deck to hold spare spars.

Ga-loche'. 1. A clog or sabot.

2. An overshoe.

3. A legging.

Gal-van'ic Ap'pa-ra'tus. (*Medical.*) Contrivances of various character and application, but agreeing in this, that they keep up a certain amount of galvanic action, which is intended to exert a remedial effect upon the parts of the body to which they are applied. While one cannot speak with confidence as to the actual value of such, we cannot condemn them, for we have but a very imperfect understanding of principles, and for the larger proportion of the curatives we possess we are indebted to empirics. This term ought not to be considered as one of reproach, for experiment has given us about all we have; rather look for the charlatans among those who pretend to have penetrated the arcana. Among the galvanic appliances may be cited bands, belts, chains, combs, rings, soles, spectacles, etc.

Gal-van'ic Bat'ter-y. Galvani, of Bologna, first observed the motion of the muscles of a frog under dissection, when the latter, lying upon a copper plate, were touched by a steel scalpel, exciting an electric current. He pursued the subject by specific experiments. Volta, of Como, repeated them, and originated the voltaic pile in 1800; also demonstrating that the influence was incident to the action of the metals, and did not abide in nerves; in fact that it was a current of electricity passing along the nerves and muscles. Duvernay in 1702 had observed and treated of the peculiar action of electricity, now known as galvanism.

Electricity, as developed by the galvanic pile, is great in quantity and weak in intensity. In this respect it is the inverse of the frictional electricity as excited by the electrical machine.

Galvanic electricity is also a steady current, while that of the electrical machine — as taken from the prime conductor — is intermittent and explosive.

From the proceedings of the National Institute of France, July 4, 1798: —

"Many of the members have been principally occupied with the care of ascertaining by a multiplicity

of experiments the phenomena of galvanism. This name is given to a discovery which Dr. Galvani, a member of the Institute of Bologna, made many years ago, and from which it results that when a contiguous series of metals, commonly different from one another, are put into contact on the one side of a nerve, and on the other with a muscle, or even with different and distinct parts of the same nerve, at the instant of the double contact a rapid and convulsive motion takes place in the muscle into which the nerve is distributed. This phenomena seems to present to the mind the idea of a circle, a portion of which is formed by the excitatory metals, and the other by the nervous and muscular organs. The rapidity of the effect, and the promptness of the communication, the nature and the participation of the exciting and interrupting substances, present very sensible analogies between the phenomena of galvanism and those of electricity. Some essential differences, however, appear to militate against this analogy, and will not suffer us to admit, at least for the present, the identity of a common principle."

A simple galvanic battery *a* consists of two bodies relatively electro positive and negative, immersed (or partially so) in a fluid which tends to act chemically upon one or both; the metals touching each other or having a conducting circuit connection.

Or: A current may be obtained from two liquids and one metal (or other substances); the respective sides of the metal being exposed to liquids of varying chemical energy upon the metal so presented.

Chemical action in all batteries develops electric energy or electro-motive force. This power is derived from the expenditure of metal, etc., and the actual value of the materials used is the principal item in determining the economic value of the process as a means of developing power. Its usual application as a motor has been in the form of the electro-magnetic engine, with coils and armatures. See ELECTRO-MAGNETIC ENGINE.

Two substances, which are conductors of electricity, being placed in contact and subject to chemical action by the presence of a fluid, will develop electric action; negative electricity passing from the body which is acted upon most powerfully, — the more easily oxidizable metal, — and positive electricity from the other substance. This is not stated as a principle, but a fact.

The metals, etc., are arranged in a series, each one of which is positive to all below it in the scale. The order is as follows: —

Zinc.	Iron.	Gold.
Lead.	Brass.	Platinum.
Tin.	Copper.	Graphite.
Antimony.	Silver.	Charcoal.

The more remote they stand from each other in the series, the more energetic will be the electric action developed by their contact under circumstances to excite chemical action.

In the formation of a simple galvanic circuit, the chemical action which excites electricity takes place through a decomposition of the liquid.

For instance, when a plate of zinc and one of copper are plunged in a weak solution of sulphuric acid, oxygen, and hydrogen, the elements of the water are separated from each other: the oxygen unites with the electro-positive zinc, forming sulphate of zinc, and develops negative electricity therein; while electro-negative copper is contrarily excited, and positive electricity is said to flow therefrom.

Some misconception may arise in the mind when it is said so frequently in a description that electric currents *flow;* but this mode of expression is perhaps as good as has been devised, and is certainly quite common. This curious agent or excitement is so imperfectly understood, that Professor Faraday remarked: "There was a time when I thought that I knew something about this matter; but the longer I live and the more carefully I study the subject, the more convinced I am of my total ignorance of electricity." The terms *flow*, *current*, etc., must, therefore, be considered merely as convenient conventional expressions.

This much seems to be admitted, that the positive and negative currents are coincident, and pass in opposite directions to restore equilibrium. In doing this they possess a certain energy which some ingenious men have made available as a positive force. In other cases the converse of the proposition is elucidated; as in electro-plating, where the energy derived from chemical action is made to excite electrical action; this again being transferred to a bath, where chemical decomposition is again effected and the equilibrium restored.

Volta discovered that by a repetition of the simple combinations, or, in other words, by a multiplication of the pairs of excited plates, the effect might be increased. His pile of plates arranged in pairs is but a multiplication of the single pair of plates, iron and copper, which caused the muscular action in the moist anatomical preparation of a frog with which they were casually brought in contact.

The cumulative effect of a number of simple batteries *b* (Fig. 2148) may be obtained by bringing them all into one circuit. Each copper plate is connected by a copper wire to the zinc of the next glass, and each transmits the electric current derived from the chemical action in its own glass, in addition to that derived from the action in the preceding glasses.

The trough-battery *c c'* was used by Sir Humphry Davy in his series of magnificent discoveries, 1806–8, when he isolated the metallic bases, calcium, sodium, potassium, etc. His trough had 2,000 double plates of copper and zinc, each having a surface of 32 square inches.

It is like the compound battery just cited, except that instead of separate glasses, a row of water-tight cells are made in a single trough *c'*, and the plates are united to a bar of wood *c* and connected by wires, the copper of each to the zinc of the next pair, and so on all through. This arrangement of the plates enables them to be withdrawn in a body from the dilute acid when desired.

The elements of the first galvanic batteries, copper and zinc plates immersed in a trough containing dilute acid, soon became sluggish and inert, and were capable of exerting their power for but a limited time without cleansing or renewal.

In 1836, Daniell's, the first permanent battery, was invented. This consists of a zinc and a copper element, each immersed in a separate saline solution, and separated by a diaphragm, originally of leather or animal membrane, but afterwards of porous earthenware. Smee subsequently substituted, for copper, silver upon which a coating of platinum was electrically deposited. Silver coated with platinum being cheaper and affording equally good results has been very generally employed, and latterly iron similarly coated has been used.

In the Austrian section of the Paris Exposition of 1867 there was exhibited a battery on the Smee principle, in which the positive element was fragments of amalgamated zinc, and the negative lead coated with platinum. This is said to be used in the Austrian telegraph-offices. Weak sulphuric acid is used as the bath in this battery.

A very permanent battery of low intensity has been devised by M. G. Farmer of Boston. It consists of an oval copper vessel forming the negative element, and which is nearly filled with a saturated solution of sulphate.

At one end is a porous cup within which is placed a smaller porous cup, which receives a cylinder of amalgamated zinc. The interior porous cup contains pure water, and the exterior cup a weak solution of sulphate of copper. The saturation of the liquid in the outer copper vessel is maintained by placing at the opposite end a third porous cup containing crystals of sulphate of copper, which are replenished as they are dissolved. If care be taken not to allow the water to fall too low, this battery will maintain its energy for many mouths.

Analogous to this is the battery of Fr. Secchi of Rome, which consists of a hollow cylinder of copper, having notches below to allow the liquid within and without to communicate freely, placed in the middle of a glass or earthenware cup, the bottom of which is covered with crystals of sulphate of copper. Over this is placed bibulous paper, fitting the annular space, over which is a stratum of sand on which rests a hollow cylinder of zinc surrounding the copper cylinder. This is filled with pulverized sulphate of copper. The space around the zinc is filled with sand. The whole is then moistened with water. According to the inventor, this battery acts for an entire year, water and sulphate of copper being added occasionally.

The gravity battery of M. Callaud of Nantes has a single cell, the separation of the liquids being effected by the difference in their specific gravities. The copper element is in the bottom, in the solution of sulphate of copper; and the zinc element is suspended in an upper part of the cell, in its own supernatant liquid. See CALLAUD BATTERY; GRAVITY BATTERY.

M. Leclanche employs in a carbon battery peroxide of manganese; subsequently he added carbon to the peroxide, the whole being ground into a paste.

Professor Bunsen, a few years since, introduced bichromate of potash instead of nitric acid in the battery bearing his name. This performs well for a time, but in consequence of the precipitation of sesquioxide of chromium upon the zinc it gradually loses power. Another modification dispenses with the porous cup, using the two liquids in mixture. The same objection attaches to this as to the former.

In the battery of Professor Thomsen of Copenhagen, a number of plates of platinum are immersed in dilute sulphuric acid, and are, by means of an electro-magnetic motor, successively brought into contact with the poles of a single cell of Daniell. The plates become covered by the decomposition of water with oxygen on one side and hydrogen on the other, giving rise to a powerful current in the platinum combination, which is maintained nearly constant when the contacts succeed one another rapidly and regularly.

To describe them more in detail: —

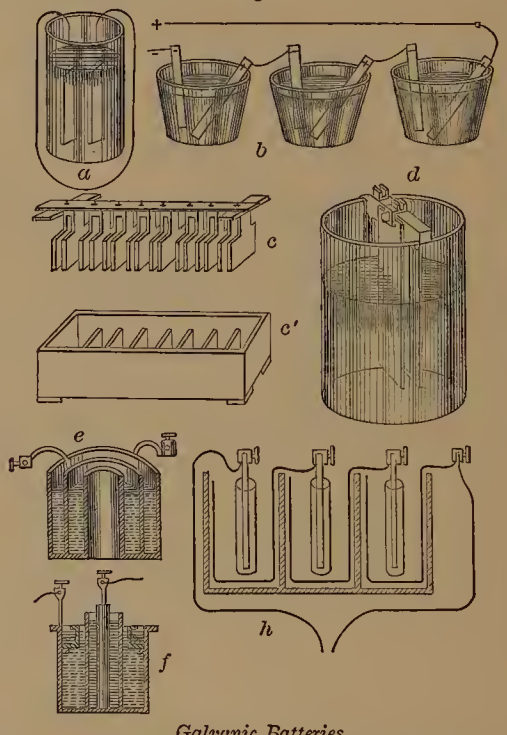
Smee's battery (*d*) has a plate of silver coated with platinum suspended between two plates of zinc, the surfaces of which have been amalgamated; that is, coated with mercury. The three plates are supported by a wooden bar, and depend within a jar partially filled with the usual acidulated solution, — dilute sulphuric acid. The wires and poles are connected with the zinc and platinum plates by small screw caps. The amalgamation of the zinc preserves the latter metal from active corrosion by the acid when the battery is not in use.

The sulphate-of-copper battery (*e*) has two concentric cylinders of copper joined to a bottom of the same metal. The middle cylinder is of zinc, and sets within the annular trough, which has a solution of sulphate of copper as an exciting liquid.

The screw caps are for attachment of the wires to the respective metals. A partition in the bath may be introduced, to allow the solution to pass, but restrain the passage of the solid products of the chemical decomposition. This would keep the metals free from a deposition which soon renders them inactive. The partition may be bladder or biscuit-porcelain.

Daniell's constant battery (*f*) is of the class of the sulphate-of-copper batteries. It differs from the preceding in having the sulphate of copper acidulated with one eighth of its bulk of sulphuric acid; in having a porous porcelain cylinder containing a solution of acid, 1 part; water, 7 parts; and in having a reserve of crystals of sulphate of copper on an annular shelf in the bath. The reserve of acid and the salt of copper gives the battery a longer vitality and accounts for the name *constant;* and its continued effectiveness and evenness of action is due to the preservation of a clear metallic surface to the copper. The action is similar to the ordinary battery; the oxide of zinc formed is dissolved by the acid set free, but the hydrogen, instead of being set free at the copper plate, combines with the oxygen of the sulphate of copper, and the copper, thus set free from the acid, combines with the copper plate of the battery, and keeps a clear metallic surface thereon.

Fig. 2148.



Galvanic Batteries.

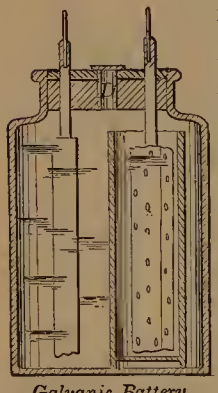
Grove's battery (*h*) is used for telegraphing and otherwhere when a powerful action is required. The glass jar has a cylinder of amalgamated zinc with an opening through one side to permit free circulation of the dilute sulphuric acid. Within this cylinder is a porous cup of biscuit-porcelain, containing strong nitric acid, in which is suspended a strip of platinum fastened to the end of a zinc arm projecting from the adjoining zinc cylinder.

An objection to this battery consists in its emission of corrosive nitrous-acid fumes.

In Bunsen's battery, the platinum of Grove's battery is replaced by carbon. The Bunsen cell, properly so called, has a cylinder of carbon immersed in nitric acid, and the porous cell, containing zinc and sulphuric acid, is placed within it. In another form, introduced by Archerau, the zinc and sulphuric acid surround the carbon cylinder and nitric acid, which are contained in an interior porous cell; in consequence of the greater proportion of positive surface, this latter form evolves a greater amount of electricity than the former. Bunsen's battery is more powerful, though less compact, than Grove's.

In the Leclanche battery, the porous vase has a graphite plate to form the positive pole, and is filled up with a mixture of powdered graphite and peroxide of manganese. The inclosing jar has a plate of zinc and is filled with sand or sawdust moistened with a concentrated solution of sal-ammoniac. The cork has a central glass tube, and over this is a disk of rubber, whose edges are secured to the wax, its middle slit forming a gas-escape valve.

Fig. 2149.



Galvanic Battery.

A newspaper item gives an account of the "smallest battery," as follows: "Mr. Collett writes from Heart's Content, 'I have just sent my compliments to Dr. Gould of Cambridge, who is in Valentia, with a battery composed of a gun-cap, with a strip of zinc, excited by a drop of water, the simple bulk of a tear.'" A telegraph that will do that must be nearly perfect.

The principal galvanic batteries are known as, —

Bunsen battery.	Gravity battery.
Callaud battery.	Grove battery.
Carbon battery.	Leclanche battery.
Daniell battery.	Single-fluid battery.
Double-fluid battery.	Smee battery.
Electropoion battery.	Thermo-electric battery.

See Deschanel's "Natural Philosophy," Part III. Appleton & Co.

Gal-van'ic Mox'a. A term applied by Fabré Palaprat to the application of platinum rendered incandescent by a galvanic current, as a cauterizing agent of the nature of a moxa.

Gal-van'ic Pile. A column of alternate plates, such as zinc and copper. See Voltaic Pile.

Gal'van-ized I'ron. The iron is cleaned by dilute acid and friction, is heated and plunged into a bath of melted zinc covered with sal-ammoniac, and is stirred about until the surface becomes alloyed with zinc. Small articles are treated in the same way, and, as they are found to be soldered together by the metal when dipped therefrom by the skimmer, they are placed in a crucible with charcoal powder, heated and shaken. Chains taken out of the zinc are shaken to separate the links. Wire is reeled through the zinc. Mallett recommends an amalgam of zinc, 2,292; mercury, 202; and about 1 of sodium or potassium; this melts at 680° F. The cleansed iron is dipped in this, and removed as soon as it reaches the temperature of the alloy.

Morewood and Rogers's method. The plates are tinned by placing them in a solution of muriate of tin in a bath, the plates alternating with granulated zinc, and thus forming a weak battery by which tin is deposited on the iron. The plates are then passed through a bath of melted zinc.

Gal-van'o-graph. (*Engraving.*) An Austrian process. A plate of silvered copper is covered by an artist with different coats of a somewhat transparent pigment, so that on the dark portions the paint is thick and raised, and the surface is relatively depressed in the light tints. A copy of this is made by the electrotype process, the darker being now the deeper portions, the whole forming an intaglio, like a copperplate, and is printed from by the copperplate-printing process.

Gal-van'o-glyph. A form of engraving. A ground is spread on a clean zinc plate and etched. Succeeding coats of varnish are spread by a roller on the ground, avoiding the obliteration of the lines, which become deeper with each coat. The finished plate becomes a matrix for a reverse impression obtained in the electro-bath, and this reverse is used to print from in the ordinary manner.

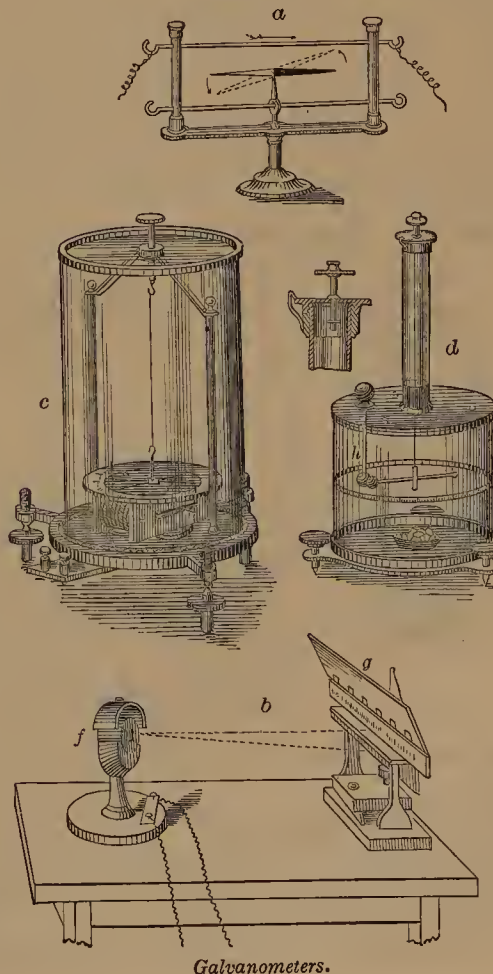
Gal'va-nom'e-ter. An instrument for measuring the strength of magnetic currents.

The instrument as usually constructed consists of a magnetized needle placed parallel to a wire, which, when electrically excited, causes the deflection of the needle. See Electrometer; Electroscope.

The discovery of this property in an electric current was by Œrsted of Denmark, in 1819. The principle was soon adopted by electricians in the construction of the indicator telegraph. Ampère, Arago, Schilling, Gauss, Weber, and Alexander all used the principle, but it received its perfected form by Cooke and Wheatstone, English patent, 1837. See Indicator-telegraph.

The tendency of the magnetic needle in the

Fig. 2150.



Galvanometers.

vicinity of an electrically excited needle held parallel to it is to assume a position at right angles to the wire conveying the current. By making the needle astatic, that is, by placing two needles with their poles in opposition to each other, they are not affected by the magnetism of the earth, and when thus arranged and surrounded by coils of wire the effect of the electric current is multiplied.

a (Fig. 2150) represents an apparatus for illustrating Œrsted's discovery. Two insulated wires are placed one above and one below a magnetized needle, and in a direction parallel to the magnetic meridian, and a current is passed through the wires; in the illustration, the current in the upper wire is represented as flowing from south to north, causing the north end of the needle to move to the west, and the south end to the east. A reversal of the current causes the needle to move in a reverse direction.

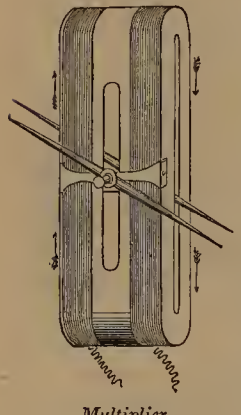
The astatic galvanometer *c* comprises an astatic needle suspended by a filament above a graduated plate, showing the degree of deflection. It is provided with set screws for attaching wires from an electro-magnet to the multiplying coil beneath the plate.

d is an instrument on the principle of the torsion balance of Coulomb, for observing the attraction or repulsion between the pole of a suspended bar magnet and that of a vertical magnet *h*. See INDICATOR-TELEGRAPH; TORSION-BALANCE.

Thomson's reflecting galvanometer, *b*, such as is employed in working the ocean cables, consists of a small mirror with a magnet laid across its back, both together weighing but 1½ grains. The reflector is suspended by a silk filament in the midst of a small circular coil of insulated copper wires *f*. A current transmitted through the cable and the coil induces a current which deflects the needle, and directs a little beam of reflected light from a lamp behind the horizontal scale *g* upon its graduated front; when the current is reversed, it sends the needle just so far in the other direction, and so by a combination of right and left motions and pauses the message is spelled out.

Gal'va-no-met'ric Mul'ti-pli-er. An instrument for increasing by repetition the intensity of the force of an electric current, as in the series of coils around the astatic needle of the needle-telegraph.

Fig. 2151.



Multiplier.

The convolutions of the wire carry the magnetic current a number of times around the needle, so as to increase its deflection, producing a considerable effect by a comparatively feeble current.

Gal'va-no-plas'tic Pro'cess. One in which the obtaining of casts by electro-deposition forms an adjunct in the process of multiplying printing surfaces, or obtaining copies of articles of "*bigotry* and *virtue*." See list under ENGRAVING; FINE-ARTS.

Gal-van'o-scope. An instrument for testing the presence of electrical forces.

It differs from a *galvanometer* in being merely qualitative, not quantitative, having no provision for determining the extent of the force.

Gam-ba'do. A leather legging for equestrians. It is wrapped around the leg, reaching from the knee to the foot, and is fastened at the side by clasps.

Gam'brel. 1. Originally, a bent stick like a horse's hind leg; used for suspending carcasses.

2. A roof with two pitches. A Mansard or curb roof.

Gam'brel-roof. (*Building.*) A roof with two sets of rafters at different inclinations. A *Mansard* roof. See CURB-ROOF.

Gam-broon'. (*Fabric.*) A kind of twilled linen cloth for linings.

Gam'mon-ing. (*Nautical.*) A lashing of ropes by which the bowsprit is bound to the cutwater to oppose the lifting action of the fore-stays.

Gam'mon-ing-hole. A hole cut through the knee of the head, for the gammoning.

Gang. 1. The rock enclosing a vein. *Gangue.*

2. A term applied to a set of tools so attached together or to a common stock as to act together; as a gang of bits, a gang-plow, a gang-saw, etc.

Gang-board. (*Nautical.*) *a.* A board with cleats, forming a bridge reaching from the gangway of a vessel to the wharf. A *gang-plank.*

b. A plank within or without the waist for a sentinel to pace.

Gang-cask. (*Nautical.*) *a.* A small cask for bringing off water in boats.

b. The cask in which drinking-water for immediate use is kept on deck.

Gang-cul'ti-va'tor. (*Husbandry.*) One in which a number of cultivator-shares are stocked in such a way as to be driven in a set; usually attached to a carriage portion on which the driver is mounted. See CULTIVATOR.

Gang-edg'er. A machine in which a movable and a stationary circular saw are mounted on one arbor for the purpose of dressing boards to uniform width, as they come from the log.

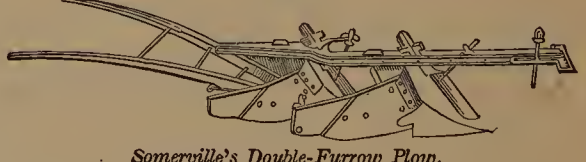
Gang-plow. Several plows stocked in one frame, generally supported on wheels and ridden by the operator.

Gangs of plows have been arranged for work by attaching a number of plows to a bar at proper distances, the motor being connected to the bar. The more usual form, however, consists of a number of plows attached to a frame which runs on wheels; the plows being the width of a furrow apart, and arranged in a receding order, so that the furrow slice, as it is raised, does not become jammed between the plows.

The wheeled frame, as used in the United States, is generally arranged with a tongue, so as to attach two or four horses, and when the plow is right-handed the off-wheel is the larger, as it runs in the furrow while the near wheel runs on the land.

The originator of the double plow seems to have been Lord Somerville, who devoted much attention to the practical details of agriculture (1799).

Fig. 2152.



Somerville's Double-Furrow Plow.

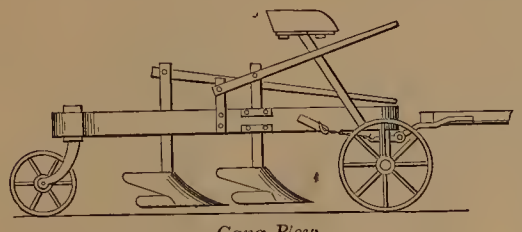
His plow, which he called a *double-furrow plow*, consisted of a beam suitably bent for the attachment of two plows, one placed laterally and to the rear of the other, as usual. Mr. Ducket of Esper, England, used, in 1797, a double plow, drawn by four horses, and turning two furrows.

The plow was not commended in England, especially in those places where it took and yet takes two persons to manage one plow. The idea of making one man operate two plows was preposterous.

Lord Somerville invented a movable-flap moldboard, by which the hinged rear portion might be set out or in, according to the width required for stubble or sod plowing. A set screw at the back secured the flap at the desired adjustment. It is shown in the illustration of his gang-plow.

In the example (Fig. 2153), the plows are moved vertically by levers. The axle is bent to depress the

Fig. 2153.

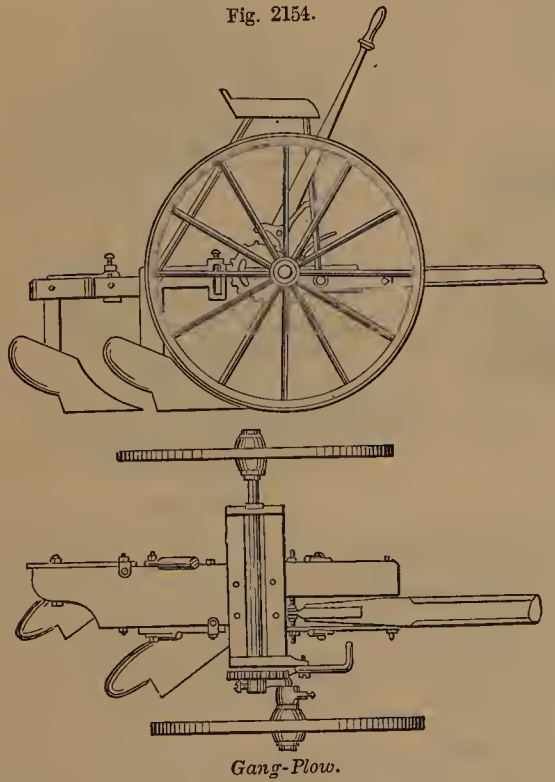


Gang-Plow.

furrow-wheel. The tongue is attached to one side of the center, to suit the position of the horses.

In Fig. 2154, the plows are raised or lowered by a lever and pawls attached to the axle, which has a toothed wheel, and has a crank near the hub for receiving the axle of the furrow-wheel, the tongue also being adjusted for the line of draught by a bolt through the clevis, and made fast to its rear end.

Fig. 2154.

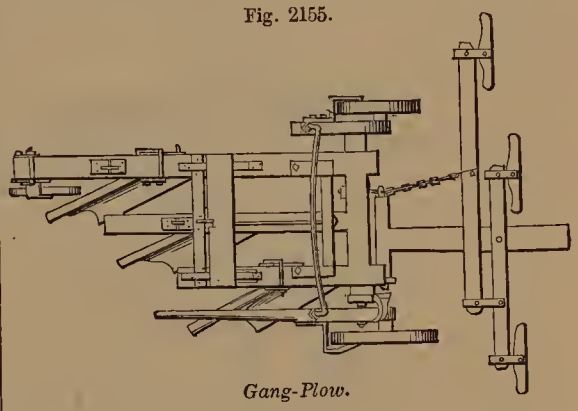


Gang-Plow.

The crank-shaped plow-standards, provided with a slot and set screw which passes through the boss and rests on the bed, are pivoted on bolts passing through a hole in the turn of the standard. The illustration shows a side elevation and a plan-view.

In the plow shown in Fig. 2155, the arrangement of the whiffletrees is designed to equalize the work of the horses. The levers, short axles, and sway bar are arranged to vibrate upon the ends of the axletree, for the purpose of raising and lowering the

Fig. 2155.

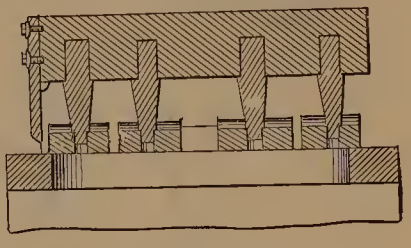


Gang-Plow.

plow-frame. When the machine is at work the sway-bar rests upon the folding frame, but when it is desirable to depress the plows the folding frame is drawn from beneath the sway-bar, which then assumes a lower position and rests upon the plow-frame.

Gang-punch. An arrangement of a number of punches in a single stock for punching fish-plates, or other things.

Fig. 2156.



Gang-Punch.

Gang-saw. An arrangement of saws placed parallel in a gate, so as to make a number of kerfs simultaneously, ripping up the log into lumber at one passage along the ways.

In the large saw-mills of the lumber regions, these saws are known as *slabbing-gangs*, *stock-gangs*, *Yankee-gangs*, *live-gangs*, differing in certain particulars and purposes. See those heads. The arrangement of several blades in one gate was introduced as early as the sixteenth century.

The illustration shows an English form of the gang-saw. *a a* is a cast-iron framework bolted to the foundation; *b*, the saw-mill floor; *c*, driving-shaft; *d d'*, fast and loose pulleys; *e*, fly-wheel; *h*, pitman; *g g*, saw-gate, which runs on slides *l l*. The log is represented as lying upon the bearer *b*, which is a part of the log-carriage, which runs upon rails on the timbers *m m*, the log being held down by the bearer above. The feed is by means of the eccentric *l'*, rod *h'*, and ratchet-wheel *p'*. The running-back motion is by means of the pulleys *l'* and spur-wheel *q'*. The other parts perhaps require no detailed description.

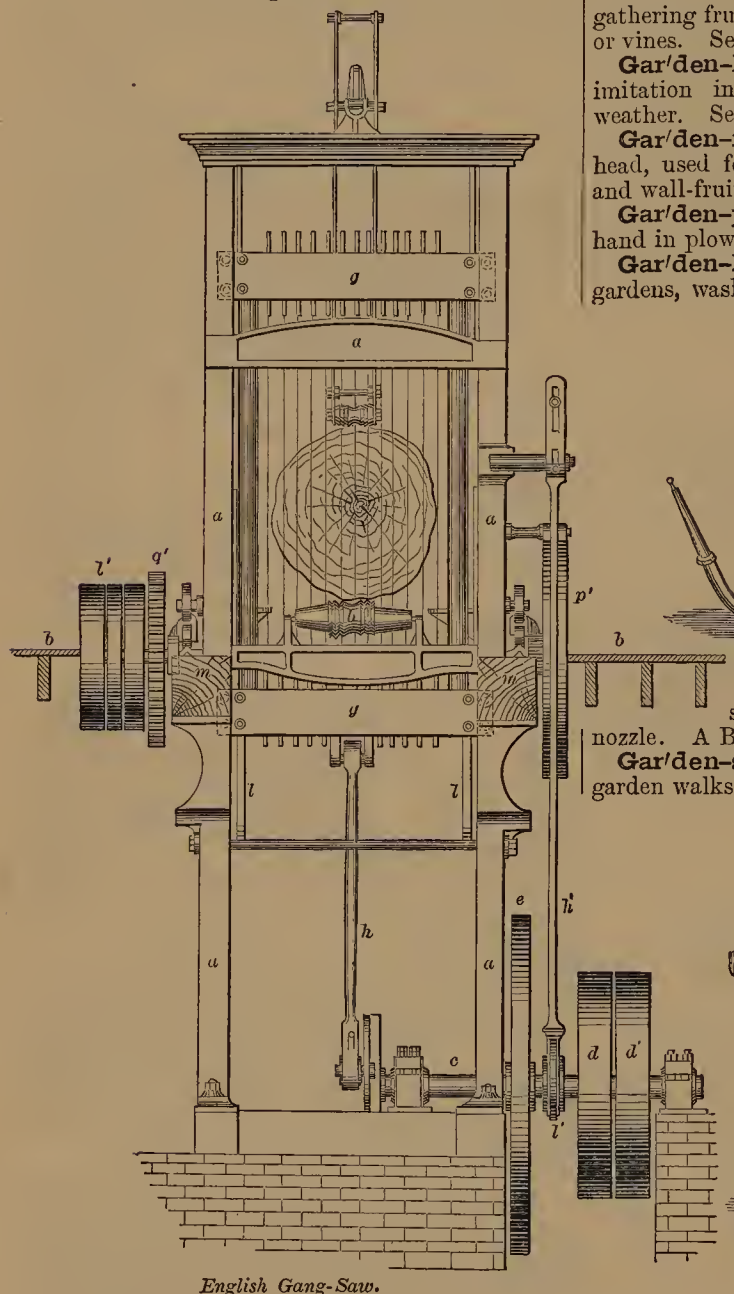
Gangue. 1. (*Smelting.*) The superfluous earthy matter of a smelting-furnace.

2. (*Mining.*) The mineral matters in which metallic ores are imbedded.

Gang'way. (*Nautical.*) The opening in the bulwarks of a vessel by which persons come on board or disembark.

Gan'is-ter. (*Metallurgy.*) A refractory material used for lining the Bessemer "convertors." It consists of crushed or ground silicious stone mixed with fire-clay. Its object is to save the iron convertor from destruction by the heat of the charge. Ground quartz, sand, and fire-clay.

Fig. 2157.



English Gang-Saw.

Atwood's compound for lining the bottoms of Bessemer converters consists of carbon, preferably that obtained from old crucibles, although anthracite or bituminous coal may be used, German, or other plastic clay, old ground fire-brick, Mount Savage stone-clay, and burned, or unburned sand.

These materials are ground together, and tamped into the mold.

Gap-win'dow. (*Architecture.*) A long and narrow window.

Gar'board-strake. (*Shipwrighting.*) The range of planks nearest to the keel. In the merchant service, the rabbet to receive the *garboard-strake* is made along the upper edge of the keel. In the navy, a groove is made half-way down the keel to receive the *garboard-strake.*

Gar'den-en'gine. A wheelbarrow tank and pump for watering gardens. See BARROW-PUMP.

Gar'den-er's-knife. A knife with a hooking blade suitable for pruning by a draw-cut.

Gar'den-er's-lad'der. A light ladder used in gathering fruit, pruning trees, or nailing up creepers or vines. See EXTENSION-LADDER; FRUIT-LADDER.

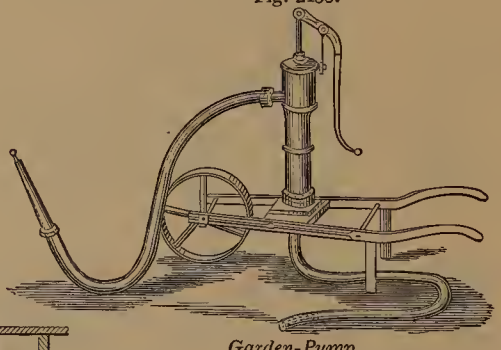
Gar'den-lounge. A seat of rustic work, or its imitation in iron, with an awning for summer weather. See GARDEN-SEAT.

Gar'den-nail. A cast nail with a pyramidal head, used for nailing up climbing plants, vines, and wall-fruit trees to brick walls.

Gar'den-plow. A small plow to be driven by hand in plowing between rows of garden plants.

Gar'den-Pump. A barrow-pump for watering gardens, washing carriages and windows. It has a

Fig. 2158.

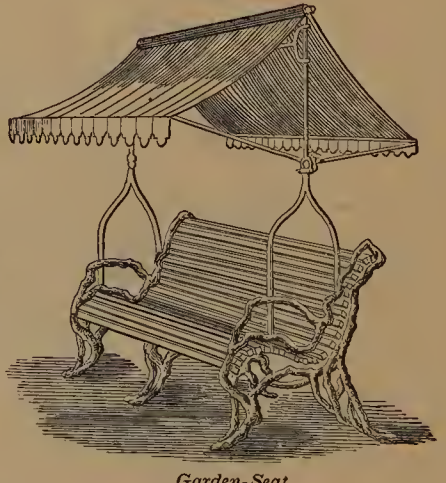


Garden-Pump.

suction-hose and a discharging hose and nozzle. A BARROW-PUMP.

Gar'den-seat. A seat for croquet grounds or garden walks.

Fig. 2159.



Garden-Seat.

Gar'den-shears. Large shears for clipping hedges and trees and for pruning.

Gar'den-syr'inge. A form of syringe for watering plants, sprinkling them with insect-destroying solutions, and so on. See GARDEN-PUMP.

Gar'goyle. A quaintly formed head of a man or animal, employed as a decorative spout for the rain-water from a roof.

Gar'land. 1. (*Nautical.*) *a.* A grommet or ring of rope, made *selvage* fashion, and used to place around a mast or spar when taking aboard or stepping a mast.

b. A bag-net used by sailors to hold provisions.

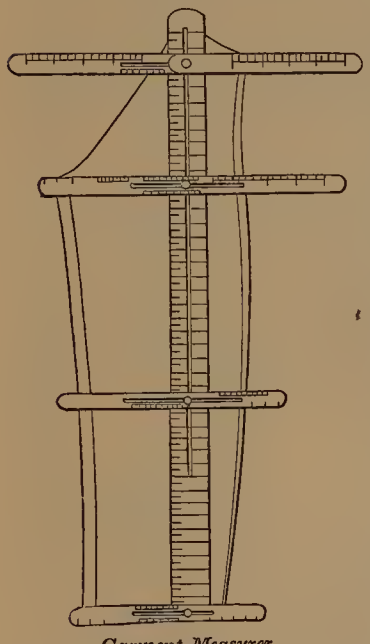
2. An ornamental band used in Gothic work.

Gar'lic-sep'a-ra'tor. A machine for extracting the corms of garlic from wheat in those States which are infested with the plant. The device is usually an apron or roller of a somewhat viscid surface, to which the corm will adhere.

Gar'ment-cut'ter. A machine having a descending cutter of a given shape, which cuts from a pile of cloth beneath it a number of pieces of its own size. The die is shifted for the next piece, and so on for each piece which goes to make up the garment. Used in large clothing manufactories.

Gar'ment-meas'ur-er. A measuring scale for laying out garments. The vertical and lateral scales are graduated for obtaining the sizes and proportions of the figure, being adjusted to agree with the measures as taken in the usual manner. At the upper end are scales adapted to the width of the back and the hight of the shoulder.

Fig. 2160.



Garment-Measurer.

Gar'net. 1. (*Nautical.*) A sort of purchase. Fixed to the main-stay as a hoisting-in tackle, but useful in other positions indicated by names, such as *clew-garnet*, etc.

2. A hinge of T-shape, the cross-bar being attached to the hanging stile or post.

Gar'nish-bolt. (*Building.*) A bolt having a chamfered or faceted head.

Ga-rook'uh. A vessel of the Persian Gulf, having a length of from 50 to 100 feet, a short keel, and a long overhanging prow and stern.

Gar'ret. An upper apartment of a house, immediately under the roof.

Gar'ret-ing. Small splinters of stone inserted in the joints of coarse masonry.

Gar'rot. (*Surgical.*) A tourniquet formed of a band and a stick, the former being twisted by the revolution of the latter.

Gar-rote'. A Spanish instrument of execution. The victim is fastened by an iron collar to an upright post, usually in a sitting posture, and a knob operated by a screw or lever dislocates the spinal column, or a small blade severs the spinal cord at the base of the brain.

Gar'ter. A semicircular plate, acting as a key, which passes through a slot in the wooden jaw of a bench-vise, and enters an annular groove in the cylindrical neck of the bench-screw, so that when the latter is unscrewed it brings *out* the jaw.

Garth. A fish-weir.

Gas. Exudations of gas from the earth have been noticed in ancient and modern times, and in many countries.

In China, these exudations, either natural or resulting from deep boring, have been utilized from time immemorial for lighting towns in the neighborhood of these jets. In boring for salt water, imprisoned reservoirs of carbureted hydrogen have been reached, and the gas thus obtained has been utilized in China, and in the valley of the Kanawha, West Virginia, in evaporating the brine.

Gas flowing naturally is or has been used in the neighborhood of Fredonia, New York; Portland, on Lake Erie; Wigan, Great Britain (in 1667); and in many other places.

The uses made of it by the Magi, or fire-worshippers of Persia, have not been properly examined or determined; but the holy fires of Baku, on the shore of the Caspian, have attained some celebrity, and are maintained by a natural stream of carbureted hydrogen.

Paracelsus remarked the disengagement of gas when iron was dissolved in sulphuric acid. Van Helmont, a Belgian chemist, gave it the name of "gas," and distinguished gases from atmospheric air, and also, on account of their non-condensibility, from vapors. Van Helmont died in 1644.

Oxygen was first discovered by Dr. Priestley in 1774; he obtained it by heating red oxide of mercury, and called it *dephlogisticated air*.

Scheele and Lavoisier a year or two later made the same discovery, independently of the English inventor, as Humboldt thinks. It was termed *empyreal air* by Scheele; *vital air* by Cordorcet. The name *oxygen* was given to it by Lavoisier.

Black and Cavendish, in 1766, showed that carbonic acid (*fixed air*) and hydrogen gas (*combustible air*) are specifically distinct aëriform fluids.

Gas was distilled from wood in Paris in 1802; from oil by Dr. Henry, in 1805; from refuse, oily, and fatty matter by Taylor, and patented in 1815.

The operations of the Chinese being unknown to the "outside barbarians," the streams of inflammable gas were for many centuries only objects of wonder and conjecture in the various countries of Europe where they issued from the soil. Occasionally, small bladders of gas had been collected and burned, but no suspicion seems to have entered the minds of the observers that there was anything valuable involved.

The artificial production of gas from coal dates in the seventeenth century, and the early examples of its manufacture and use are as follows: —

Dr. Clayton, rector of Crofton, England, distilled illuminating gas from coal, and detailed the experiment to his friend Dr. Boyle, in 1688. Dr. Boyle announced it to the Royal Society before his death, which happened in 1691. Dr. Clayton obtained what he called an "uncondensable spirit," which, as it issued in a jet, was caught in a bladder and used for experiments; the gas being repeatedly lighted and blown out.

About fifty years afterwards the account was published in the "Philosophical Transactions," and appears to have drawn attention to the subject, as from this point we find a chain of experimenters and then a line of practical developers.

If the series is to be briefly stated, we shall give it thus: Dr. Clayton, Bishop Watson, Murdoch, Winsor, Clegg; a clergyman, a bishop, an engineer, an enthusiast, a mechanic.

In 1726, Dr. Hales, in his work on "Vegetable Statics," states that 158 grains of coal yield 180 cubic inches of gas.

In 1750, Watson, Bishop of Llandaff, distilled coal, passed the gas through water, and conveyed it in pipes from one place to another.

In 1786, Lord Dundonald erected ovens or retorts in which he distilled coal and tar, and burned the issuing gas. He seems to have considered it an amusing experiment, and no more.

In 1792, Mr. Murdoch, of Redruth, Cornwall, England, erected a gas-distilling apparatus and lighted his house and offices by gas distributed through service-pipes.

In 1798, Murdoch lighted with gas the works of Boulton and Watt, Soho, near Birmingham. On the occasion of a public rejoicing for peace, 1802,

he made an illumination of the Works ; probably an outside exhibition of his pet, on the walls of the establishment. Trafalgar, Austerlitz, and Jena, within four years afterwards, is a curious commentary.

In 1801, Le Bon, of Paris, lighted his house and garden, and proposed to light the city of Paris.

The English periodicals of 1803 and thereabout refer to the proposition of Murdoch to use the gas obtained by the distillation of coal, and state that the use of the gas for light, heat, ammonia, or oil would be an infringement of the patent of the Earl of Dundonald ; farther, that the amount of water produced by the combination of the hydrogen of the gas and the oxygen of the air would suffuse the curtains of a room with moisture, and would render it necessary "to wring out the curtains and other linen furniture of the apartments on the morning subsequent to the illumination by the burning of the coal smoke." — *Monthly Magazine*, London, June 1, 1805.

In 1803 – 4, Winsor lighted the Lyceum Theater and took out a patent for lighting streets by gas. He established the first gas-company.

In 1804 – 5, Murdoch lighted the cotton-factory of Philips and Lee, Manchester, the light being estimated as equal to 3,000 candles. This was the largest undertaking up to that date.

In 1807, Winsor lighted one side of Pall Mall, London ; the first street lighting.

Westminster Bridge was lighted in 1813.

Houses of Parliament, London, in the same year.

Streets of London generally, 1815. Streets of Paris, the same year.

James McMurtrie proposed to light streets of Philadelphia, 1815.

Baltimore commenced the use of gas, 1816.

Boston, 1822.

New York City, 1825.

The Newton gas-well, six miles from Titusville, Pa., discharges at the rate of three millions of cubic feet of gas every day of twenty-four hours. The gas issues under a pressure of from twenty to thirty pounds per square inch, and for the most part goes to waste. Pipes have been laid to Titusville, and two hundred and fifty dwelling-houses, shops, etc., are now supplied with the gas for illumination and fuel. For heating purposes it is admirable, but for illumination it requires to be passed through naphtha, as it is deficient in carbon.

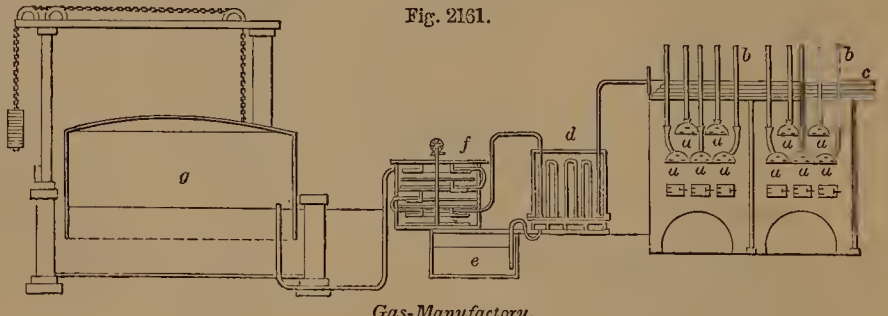
If the owners could satisfy themselves of the continuity of the gas flow, we presume that pipes would be laid from the well to several of the large cities, such as Pittsburg, Cleveland, and Buffalo.

The process of making gas consists in the distillation of coal, though other forms of hydrocarbon will yield it, and the subsequent purification of the same to purge it of noxious matters, — tar, ammonia, and sulphur. These operations are conducted respectively in the GAS-RETORT, CONDENSER, WASHER, and PURIFIER (which see).

The coal is placed in the retort *a* by means of long scoops, which are handled by three men, two scoopfuls forming a charge, — 220 pounds. The retort is of iron or clay ; the latter is now preferred. The retort has its open end exposed at the furnace-wall, so as to receive the charge, and is surrounded by the flames and heat of the furnace. Each retort is connected by its branch pipe *b* with the main *c*, which conducts the gas evolved to the condenser *d*. The operation of charging the retort is quickly and skillfully performed, so as to limit the escape of gas. When the charge is introduced, the cap is replaced and luted to make the joint gas-tight. The fire expels the gas from the coal in the course of five hours, and the coke is then ready to be withdrawn. This is done by long rakes, and it is wetted to prevent its burning. The coke weighs less than the coal by the amount of gas evolved, but is nearly double the bulk.

The gas flows in company with other vapors from the retort, and these impurities are removed by successive operations. It is first conducted through the convoluted pipes of the *condenser d*, by which the gas is cooled and the tar precipitated. From thence it passes to the *washer e*, in which it is brought into intimate contact with water to remove the ammonia, which has so great an affinity for water that it leaves the gas. From thence the gas is conducted to the *purifier f*, where it is passed between layers of damp, powdered lime, arranged in a tier of shelves on a box. The lime absorbs the sulphur and permits the gas to pass off in a purified state, fit for consumption. See also GAS-PURIFIER.

Fig. 2161.



Gas-Manufactory.

The holder *g*, in which the gas is stored, consists of inverted sheet-iron cylinders, which are supported by chains and counterweights from pillars of iron. The cylinder is open at its lower end, and the edge dips into a tank of water, so that the cylinder rises as the gas is driven into it and sinks as it is withdrawn by consumption. The inlet and outlet of the gas is by pipes whose terminations are above the surface of the water. From the holder the gas proceeds to the mains and service-pipes. See GAS-HOLDER.

To govern the flow of the gas, a regulator or governor is applied (see GAS-REGULATOR), whose duty it is to limit the flow, according to the elevation of the locality to which the gas is supplied, and also to maintain an equable pressure to avoid flickering and inequalities in the light. One form of regulator is a bell-shaped chamber suspended from a beam whose other end has a balance-weight, being in construction similar to a gas-holder. Gas is admitted to the interior of the "bell" by a pipe whose end is above the surface of the water in the tank into which the bell is inverted, and a similar pipe conveys the gas away. Over the upturned mouth of the inlet-pipe is suspended a cone which partially closes the aperture when the pressure of gas is greatest, and uncloses the opening when the pressure diminishes, so that the size of the orifice is in the inverse ratio of the pressure, and the consequent speed of the passing fluid. Valves working on the principle of the bellows, and actuated by the ascending and descending bell, are effective for this purpose.

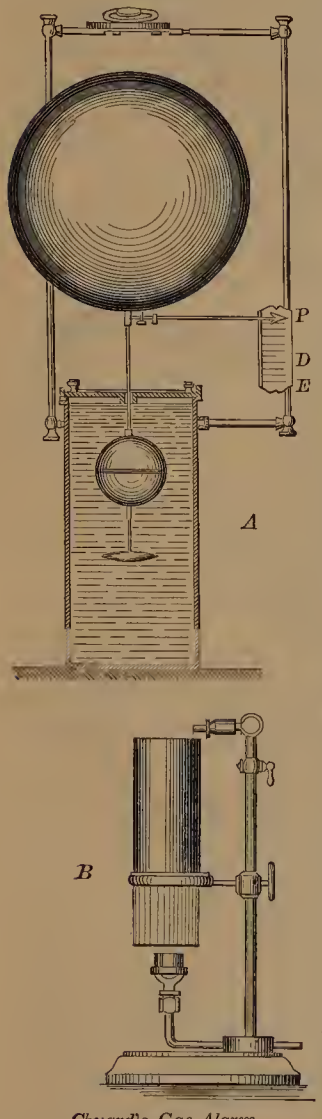
In the distribution, valves are used to cut off the

supply from certain localities for repair or other purposes. These are hydraulic water-traps, in fact, consisting of inverted cups shutting down over the top of the pipe, which is turned up for that purpose beneath a small dome; or other mechanical devices are used, such as spring or slide valves, which are essentially similar to some described under VALVES. An essential part of the distributing apparatus is the meter; these are *wet* or *dry*, and are described under GAS-METER.

Gas-a-larm'. A device invented by M. Chuard, and described in the forty-fourth volume of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, 1845.

It is called by him a "gasoscope" (*A*), and was intended to indicate the presence of carbureted hydrogen in mines and dwellings. It is constructed like a very delicate areometor, with a light metallic stem, surmounted by a thin glass globe filled with atmospheric air. The lower ball, which gives it buoyancy, and the suspended weight, which maintains its vertical position, are submerged in a vessel of distilled water. The weight is graduated, so that the normal condition of the air causes the finger to indicate zero on the scale; *P*, pure. When the surrounding air becomes mixed with hydrogen, the relative weight of the glass globe will be changed, its contained air being heavier than the air and gas by which it is surrounded. It will then sink, and the pointer will indicate upon the graduated scale a dangerous degree of suffusion of the air; *D*, danger. When nearing the point *E*, explosion, a stud on the stem trips a trigger or comes in contact with a magnet, by which a lever is moved and a hammer caused to sound upon an alarm-bell.

Fig 2162.



Chuard's Gas-Alarm.

Several other devices founded upon endosmotic action have been proposed. A bladder of air is placed in a position exposed to the action of escaping hydrogen, and by the absorption of gas its form or specific weight becomes changed, the change being made the means of mechanically actuating a device which sounds the alarm.

Another gas-alarm for mines or rooms consists of a galvanic battery with a bell and a glass tube filled with chloride of palladium. This metallic salt is extremely sensitive to the presence of carbonic-oxide gas. A small quantity of the gas will at once throw down some of the metal from the solution, and this precipitate collecting in the bottom of the tube, at once establishes a connection in the current of electricity, and the violent ringing of a bell will warn the sleeper of his danger.

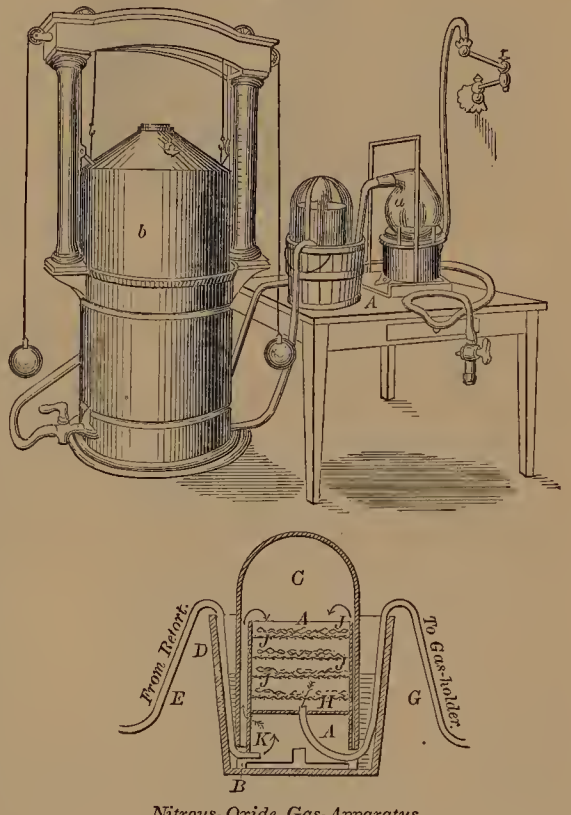
Van der Weyde's burglar-alarm *B* is so arranged that the opening of a door or window to which it is connected will turn a gas-cock and emit gas into a cylinder, where it is exploded by contact with a small, constant burner above.

It has an upper metallic cylinder and a lower apron of wire gauze, into which the gas enters as the lower gas-cock is turned by the opening of the door. As the gas reaches the upper end of the tube and is ignited at the burner, it produces a shrill sound which may be heard by the inmates of the house. The apparatus may be placed within the room which is being surreptitiously entered, or at any other point, connected by wire with the door of said room, and conveniently situated to alarm the person in charge.

Gas'a-lier. A stem or dependent tube having a group of branches tipped with gas-burners.

Gas-ap'pa-ra'tus. The apparatus for making nitrous-oxide gas is shown in Fig. 2163. It consists

Fig. 2163.



Nitrous-Oxide Gas-Apparatus.

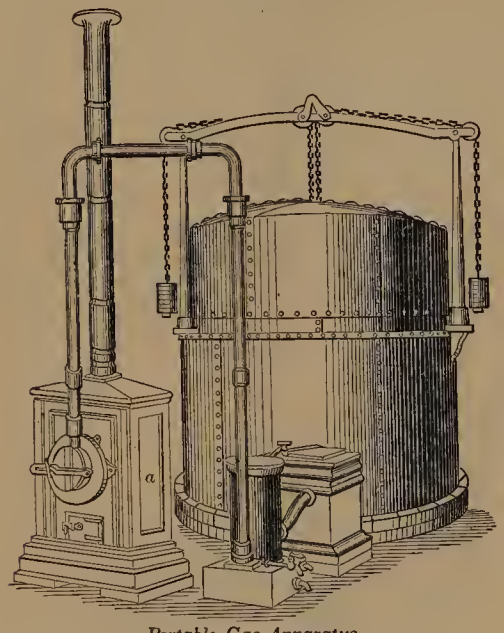
of a retort *a*, purifier *A*, and gas-holder *b*. The purifier *A* is a copper cylinder, divided into two chambers by a gas-tight horizontal disk *H*. The cylinder is pierced just below the disk by a number of small holes. *B* is a wooden stand; *C*, a glass vase covering the cylinder; *K*, a short pipe, to which the conducting tube is attached, curving under the vase, and passing into the lower chamber and connecting with the retort by a rubber tube *E*. A similar pipe communicates with the upper chamber, and is connected with the gas-holder by tube *G*. The cylinder is loosely fitted with four wire-cloth disks *J*, placed equidistant, on which is spread lime.

The whole apparatus sits in a vessel *D*, which should be about half full of water.

The gas passes from the retort by tube *E* into the lower chamber, is partly washed by the water, passes out at the small holes into the inside of the vase, up into the top of the cylinder, down through the line into the pipe *A*, and to the gas-holder by tube *G*, as indicated by the arrows.

Fig. 2164 shows a portable apparatus for making the usual carbureted hydrogen for manufactories or

Fig. 2164.



Portable Gas-Apparatus.

country mansions, having a furnace and retort *a*, a condenser, washer, purifier, and gas-holder, connected by pipes with couplings, so as to be set up on a pavement or floor without special excavation or building. See also CARBURETOR, and the subjects under the following heads: —

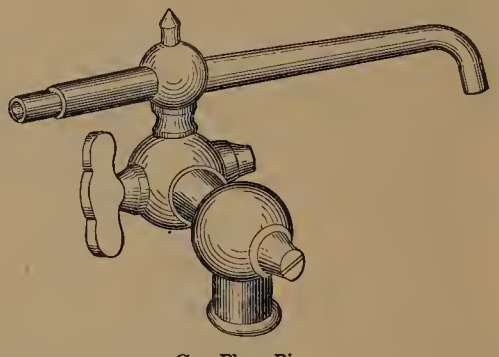
Ammoniacal gas-engine.
Argand-burner.
Bat's-wing burner.
Burner.
Butterfly-burner.
Carbureting-machine.
Air and gas
Compensator.
Detonating-tube.
Dry-meter.
Electrophorus.
Eudiometer.
Exhauster.
Fan-tail.
Fish-tail burner.
Gas.
Gas-alarm.
Gasalier.
Gas-apparatus.
Gas-bellows.
Gas blow-pipe.
Gas-bracket.
Gas-burner.
Gas-check.
Gas-compensator.
Gas-condenser.
Gas cooking-stove.
Gas-engine.
Gas-fitters' tongs.
Gas-fitting tool.
Gas-gage.
Gas-generator.
Gas-governor.
Gas-heated furnace.
Gas-heater.
Gas-holder.
Gasing.
Gas-injector.
Gas-lighter.
Gas-lighting by electricity.
Gas-machine.
Gas-making.
Gas-meter.
Gasometer.
Gasophaner.
Gasoscope.
Gas-pipe.
Gas-pipe tongs.
Gas-pressure indicator.
Gas-pressure regulator.
Gas-purifier.
Gas-register.
Gas-regulator.
Gas-retort.
Gas-retort charger.
Gas reverberatory furnace.
Gas-stove.
Gas-torch.
Gas-washer.
Hydraulic main.
Hydraulic valve.
Hydrocarbon burner.
Lid-closer.
Lighter.
Lighting gas by electricity.
Nitrous-oxide apparatus.
Oil-gas.
Oxygen-gas apparatus.
Oxyhydrogen-light.
Petroleum-still.
Photometer.
Quicksilver-valve.
Scrubber.
Seal.
Switch.
Tar-well.
Tell-tale.
Torch.
Vapor-burner.
Water-gas.
Wet-meter.

Gas-bel'lows. A kindling device consisting of a hollow poker attached by a flexible tube with the gas-pipe. The end of the poker is perforated, and is thrust among the coals in the grate or furnace, so that the ignited jet may start the fire.

English patents of 1854 and 1856 describe bellows connected with a gas-reservoir, and also a portable apparatus containing compressed gas, and having a nozzle which may be thrust among the coals.

Gas Blow-pipe. A form of blow-pipe designed to be attached to a gas-pipe, for using gas instead of

Fig. 2165.



Gas Blow-Pipe.

oil or alcohol. The atmospheric air is driven through the center tube, adding force and giving a cylindrical form to the flame, which issues at an annular opening.

Gas-brack'et. A branch proceeding from a wall and having on its end a burner or burners.

Gas-burn'er. The jet-piece at which the gas issues.

It consists of a slit or of a number of orifices disposed so as to produce the shape of flame required.

The *fish-tail* flame is made by two oblique orifices at an angle of about 60°, so as to cause the jets to cross each other; the object is divergence, to spread the gas and bring the carbureted hydrogen in contact with the air.

The *cock-spur* burner *a* has three apertures, one central and the others divergent.

The *union* burner *b* has a row of holes so disposed that the jets touch and nearly coalesce, each maintaining in part its distinctiveness.

The *bat's wing* *c* has a slit aperture instead of holes, giving a flat, fan-like flame.

The *beak* has a round, smooth hole $\frac{1}{28}$ of an inch in diameter.

The Boccius light, named after the inventor, consists of two concentric, metallic cylinders, placed on the flame and within the usual lamp-glass, so as to modify the combustion and increase the brilliancy of the light.

The *Argand* burner *d* is a hollow annulus, the

upper surface of which is pierced with a circle of small openings having a diameter of from $\frac{1}{32}$ to $\frac{1}{60}$ of an inch. It also has a central aperture to allow access of air to the inside of the flame as well as the outside.

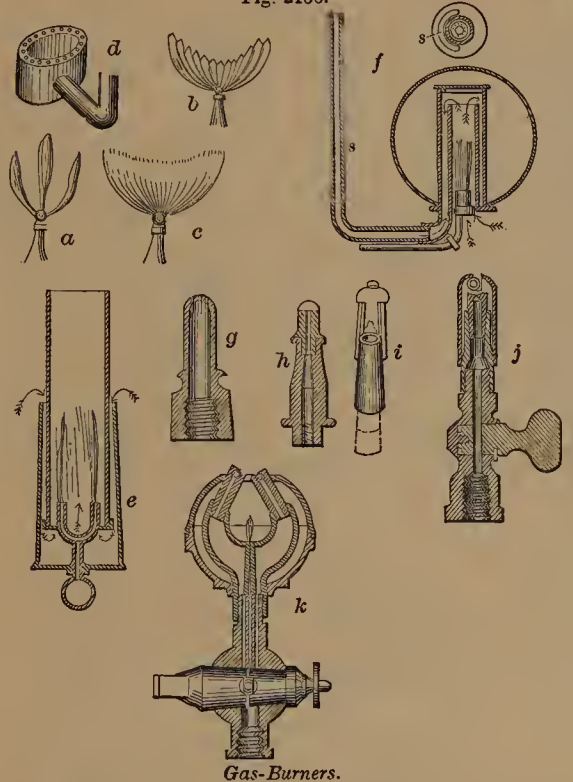
The jets from each hole unite to form a cylindrical flame. The holes are about $\frac{1}{6}$ of an inch asunder, and when there are ten holes in the circle the middle opening will be $\frac{1}{70}$ of an inch in diameter. With twenty-five holes the central orifice will be about 1 inch in diameter.

Burners with ten, fifteen, twenty, or twenty-five holes have central apertures $\frac{3}{8}$, $\frac{1}{2}$, $\frac{2}{3}$, and $\frac{25}{100}$ of an inch in diameter. The flames of these burners may be raised without smoking to the height of $3\frac{1}{2}$, 3, $2\frac{1}{2}$, and 2 inches respectively. The glass chimneys for the burners mentioned should be $\frac{8}{10}$, $\frac{2}{10}$, $\frac{3}{10}$, $\frac{5}{10}$ of an inch in diameter respectively.

The *Bude* burner has two or three concentric Argand rings.

The *Winfield-Argand* has a metallic button above the annulus to deflect the central current laterally.

Fig. 2166.



Gas-Burners.

A contraction of the chimney above the jet has a similar effect upon the exterior envelope of air.

Leslie's Argand has a series of small tubes arranged in a circle, which eject the gas in a conical form just below the contraction of the chimney.

Frankland's burner *e* is an Argand with two chimneys, the outer one standing on a plate so as to be closed at bottom, and the air passing between the two for the supply of the flame.

Faraday's ventilating burner *f* removes the products of combustion, and prevents their mingling with the air of the apartment. It is shown in vertical and horizontal section, the arrows indicating the course of the air, and *s* being the exit-pipe for the effete air and gases.

g is a three-slit burner.

h is a soapstone-tipped burner.

In *i*, the elongated ring upon the burner has on its sides two arms supporting fine platinum wires bent over at the top, between which is a spongy platinum with wires at the bottom to ignite the gas issuing from the jet of the burner.

j is also a platinum coil-lighter, the resistance of the metal causing it to become red-hot when a current of galvanic electricity is passed through it.

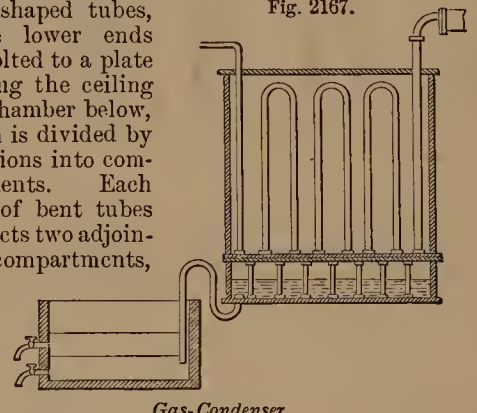
In *k*, a small axial tube supplies the jet in the bulbous cap around the main burners; the jet remains lighted while the main pipe is closed, and is closed when the main pipe is lighted. The same spigot acts to make these changes of connection, having side ramifications which conduct to the axial tube in the former case, and a divisional piece which closes the said tube in the latter case.

Gas-check. A ring or plate at the rear of the charge chamber in some kinds of breech-loading ordnance, such as Broadwell's, Krupp's, Armstrong's, etc. It is designed to close the rear aperture completely, and prevent escape of gas rearward. See GAS-RING.

Gas-con-dens'er. The gas from the retorts is passed through the condenser to rid it of the tar. It comes hot from the retort, and is passed through the convoluted pipes, which are surrounded by water, precipitating the tar. It is the second in the series of apparatus in gas-making, — *retort, condenser, washer, purifier.* From the latter it passes to the gas-holder and the distributing mains. The condenser gathers about eight or ten gallons of tar from the gas produced from 2,000 pounds of coal. The tar is used, in connection with paper and gravel, for roofing; and combined with sawdust, gravel, and various other matters, in making pavement. It is distilled to obtain different grades of hydrocarbon liquids used for illumination and in the arts.

The form of the condenser is a tank having a submerged series of siphon-shaped tubes, whose lower ends are bolted to a plate forming the ceiling of a chamber below, which is divided by partitions into compartments. Each rank of bent tubes connects two adjoining compartments,

Fig. 2167.



Gas-Condenser.

so that the gas is compelled to pass through each set, by which it is brought to the temperature of the air, the tar and ammoniacal liquor being condensed and collected in the lower chamber, whence they are drawn off into a cistern.

Where 100,000 cubic feet of gas are produced every twenty-four hours, the condenser should have a surface of from 800 to 900 square feet.

Gas-en'gine. An engine in which the motion of the piston is caused by the combustion or sudden production or expansion of gas in a closed cylinder.

The first gas-engines were gunpowder-engines, the gas generated by the explosion being the means of expelling the air, the condensation of the gases producing a partial vacuum in the chamber. See Brown's English patent, vacuum engine, 1824.

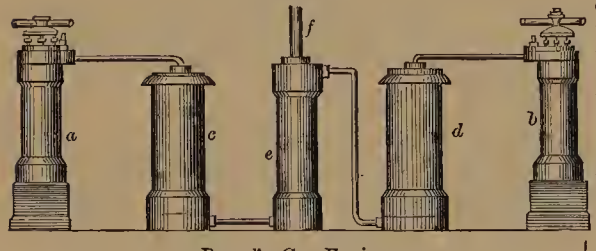
D'Hautefeuille, in 1678, seems to have been the

first to use this power ; Hugyhens applied it in a cylinder so that the atmospheric pressure might force a piston downward when the vacuum was thus formed beneath it. Papin substituted a bell-valve over the air-eduction port, for the collapsible leathern tubes of Huyghens.

In 1791 Barber took an English patent for a gas-engine in which a stream of carbureted hydrogen gas was introduced at one induction port and a quantity of atmospheric air at another, the resulting combustion giving an explosive force against the piston. Street, in 1794, proposed to use the expansive power of heated gas instead of its explosive power. Lebon's French patent of 1799 described the distillation of carbureted hydrogen from coal, and its introduction into the cylinder beneath the piston and simultaneously at another channel a proper proportion of atmospheric air. The mixed gases were then exploded by the electric spark (see also Pinkus's English patent, 1840), their dilatation furnishing the desired motive-power. The engine was self-regulating and operated two pumps, one of them designed to introduce the supply of gas, and the other that of air.

Brunel's gas-engine (1825) consisted of five distinct cylindrical vessels ; the two exterior vessels *a* and *b* contain the carbonic acid, reduced to the liquid form, and are called the *receivers ;* from these it passes into two other vessels *e* and *d*, called *expansion vessels.* These latter have communication with the central vessel or working cylinder *e*, the piston of which is operated by the alternate expansion and

Fig. 2168.



Brunel's Gas-Engine.

contraction of the gas, giving motion to machinery through the medium of the piston-rod *f*.

Heat and cold are alternately applied to the contents of the receivers by means of steam, water, etc., circulating through pipes which pass through the *receivers.* The air in the *expansion*-chambers presses upon a body of oil in the chamber, and through it transmits the pressure to the piston. It being much easier to make an oil-tight than a gas-tight joint, the direct access of gas to the piston is thus obviated.

If water at 120° be passed through one cylinder, the gaseous contents will have an expansive pressure of 90 atmospheres, and cold water be passed through the other receiver, the latter will exert a force of from 40 to 50 atmospheres. The difference in the pressures, say 45 atmospheres to the square inch, will be the power on the piston (at the start).

Davy and Faraday, about 1823, succeeded in reducing several gases to a liquid state by means of great pressure and very low temperature. Upon releasing the pressure, the gases were found to again expand to their original volume. This discovery again turned attention to gas-engines. It was ascertained — a result which was of course expected — that in the condensation a considerable amount of caloric was rendered sensible, and that in re-expanding the same amount of caloric was rendered latent.

Cooper, 1835 (English patent, No. 6875), describes an engine in which one part oxygen and two parts hydrogen are ignited to produce a vacuum alternately on each side of a piston.

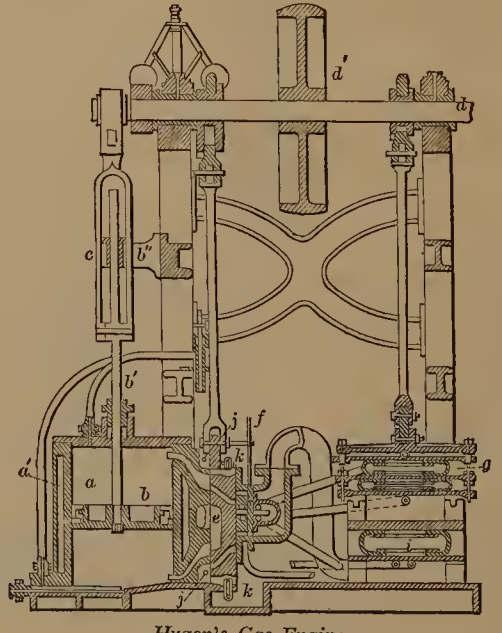
In Sir James C. Anderson's (English patent, No. 11,273), two cylinders open at the ends are placed end to end. A web of gun-cotton is fed to cylinders alternately and ignited by electric spark.

Johnson's British patent of 1841 proposed to introduce pure hydrogen gas and oxygen instead of atmospheric air, in order that the water, the resultant of the explosion, might render the vacuum practically perfect.

Otto and Langen's gas-engine is an upright hollow column, having a heavy piston, whose rod is a rack acting upon a cog-wheel on the fly-wheel shaft ; as the piston ascends, the cog-wheel slips loosely on the shaft. The mixed gases, coal-gas and air, are exploded by communication with the gas-jet, which is kept constantly burning. As the gases rapidly condense after the explosion, the atmospheric pressure, aided by the weight of the piston, is made effective upon the shaft of the wheel by the engagement of the rack-teeth with those of the spur-wheel. See Dr. Barnard's "Report of the French Exposition," pp. 60 – 63. The same excellent report gives an account and illustration of the Lenoir gas-engine, of which three hundred were, in 1862, in use in France. The essential portions are a horizontal cylinder with a piston which communicates motion by a crank to a shaft which carries a heavy fly-wheel. The great weight of this wheel is for a double purpose : to absorb the force suddenly developed by the explosion, and so moderate the speed at this period ; and, secondly, to carry the machine over the one half of its period in which the driving-power is absent. Like the Otto and Langen engine, a water-jacket around the cylinder prevented the latter from becoming overheated. The explosion was made by electric spark. See AIR-ENGINE.

In Hugon's gas-engine, a small quantity of water is introduced into the cylinder along with every charge of gas. By its evaporation the water absorbs

Fig. 2169.



Hugon's Gas-Engine.

some heat, and in becoming steam it prevents the abrupt fall of pressure which follows the explosion

when the gases are used entirely dry. The mode of firing is by permanent lights placed on the outside of the cylinder, jets being inflamed at these and taken to the charges at the respective ends of the cylinder. As the explosion exhausts the oxygen of the cylinder, the jet is extinguished. The gases are admitted by a slide-valve, and the lighted jet by a supplementary slide.

The cylinder is shown at *a*, the small space *a'* being the interval between it and the jacket, which is filled with cold water.

b is the piston with its rod *b'*, guided by the support *b''*.

c is the connecting-rod, which is forked below, and attached above to the crank.

d is the arbor moved by the crank, and carrying the pulley *d'*, by which the motive-power is applied. The same arbor carries the fly-wheel at the extremity.

e is the slide carrying the portable gas jets *k k*, and serving also to open the escape passage to the exhaust gases.

f is the induction slide, admitting the explosive mixture to the cylinder.

g is the compressor by which the inflammable gas is introduced into the chamber where the mixture is formed.

i is the reservoir of inflammable gas.

j j are the fixed jets, and *k k* the movable.

In Hugon's English patent 653 of 1863, the explosive force of the gas acts upon a column of water which transfers the force to the piston.

See also Lenoir's patent, March 19, 1861; Dick's, 1867; Million, 1867.

The ammoniacal engine has been termed a gas-engine, but this latter name is more fairly applicable to those engines in which the force is obtained by the inflammation of the charge, rather than to those in which the motor is an elastic vapor under pressure.

Frot's ammonia-engine resembles the steam-engine so closely that comparative experiments with the vapor of water and of ammonia have been made with it. See AMMONIACAL ENGINE.

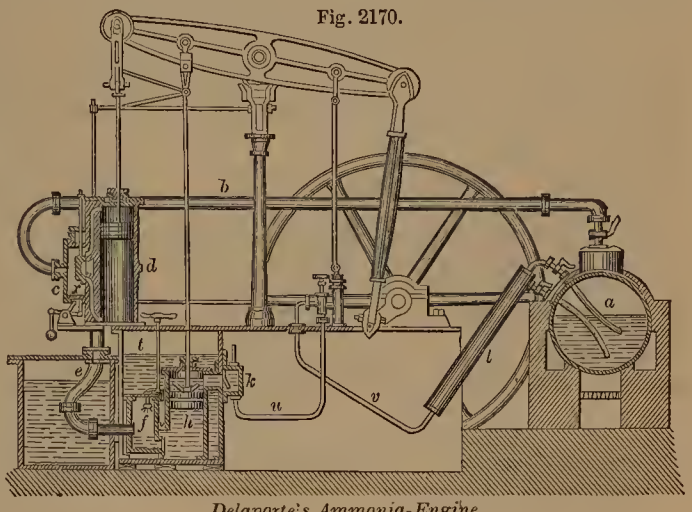
R. Waller (English patent, No. 1019 of 1854) uses condensible and permanent gases; as carbonic acid, ether, air. Vaporizes by steam or hot water.

Arbos (English patent, 3108 of 1862), steam and gas combined.

N. H. Barbour (No. 46,769, March 14, 1865) has a traveling car with reservoir supplied with carbonic acid from condensing stations along the route. See COMPRESSED AIR-ENGINES on this principle; Bompas and others, pp. 602–604.

In Delaporte's ammoniacal gas-engine, *a* is the boiler, *d* the cylinder, and *b* the tube communicating between the cylinder and the boiler. *c* is the valve-box, and *x* the slider by means of which the gas is introduced alternately above and below the piston. *e* is the eduction-pipe and *f* the condenser and dissolver. In this machine, the condenser and dissolver are not separate, as in Mr. Frot's. The water of injection is introduced by a pipe and rose-jet at the top of the condenser *f*. The solution passes from *f* into *h*, from which it is withdrawn by the piston *h*, passing through the reservoir *k* and the tubes *u* and *v*, by which it is returned to the boiler. As its return is opposed by the elasticity of the gas in the boiler, it must be forced in, and a small forcing-pump is employed for this purpose. The tube *v* is surrounded by a jacket *l*. The water which has been deprived by heat of its ammonia is withdrawn from the bottom of the boiler by the lower tube, and passes into the jacket *l*, where it imparts a portion of its heat to the solution in the tube *v*, which is on its way to the boiler. It is then discharged by a connection, not shown, and carried through a refrigerator, which is also not shown, after which it is conveyed into the vessel *t*, and is employed for injection into the dissolver *f*. See also AIR-ENGINE.

Fig. 2170.



Delaporte's Ammonia-Engine.

Gas-fit'ter's Gage. An arrangement by which the tightness of the joints in a line of pipe is ascertained. The pipes being filled with air by a pump, the pressure-gage in connection therewith remains stationary if the joints are perfect. If the gage fall, ether may be admitted to the interior and the escape detected by a torch.

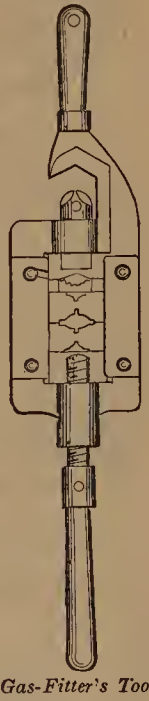
Gas-fit'ter's Tongs. One for pinching gas-pipe, holding them while screwing joints together, or screwing gas-burners into their sockets.

In Fig. 2172, a cutter for cutting off the ends of pipes, a scraper for clearing its surface before forming the screw, dies for cutting the thread, and a cramp for holding the pipe to turn it, are arranged in a frame or stock fitted for the purpose.

Fig. 2171.

Gas-Fitter's Tongs.

Fig. 2172.



Gas-Fitter's Tool.

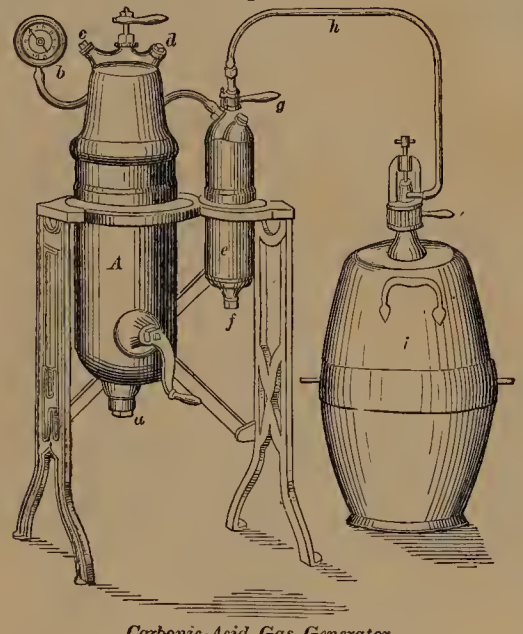
Gas-fur'nace. 1. A small furnace, much employed for laboratory purposes, and which is so arranged as to receive the maximum heating powers of the gas without regard to its illuminating purposes. Various forms have been contrived.

2. A furnace of which the fuel is gas from burners suitably disposed in the chamber for the purpose required. Steam-boilers and metallurgic furnaces are sometimes thus heated. See Siemen's English patent, 1861.

Gas-gage. An instrument for ascertaining the pressure of gas. A bent graduated tube containing water or mercury, open at one end and with the other screwed into the vessel containing the gas. It resembles Lind's anemometer (p. 99), except that the open end is exposed to the gas pressure instead of wind pressure.

Gas-gen'er-a'tor. A chamber in which gas is evolved. The term includes: — 1. The retort in

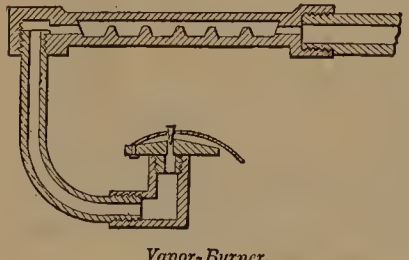
Fig 2173.



Carbonic-Acid Gas-Generator.

which volatile hydrocarbons are evolved by heat, as in the ordinary gas-apparatus. 2. The machine in which air is saturated with the vapor of liquid hydrocarbon. (See CARBURETOR.) 3. The machines in which carbonic-acid gas is evolved for aërating water or other purposes. Such is that shown in Fig. 2173, in which *A* is the vessel containing the sulphuric acid in an upper chamber, and the other materials in a lower portion. *a* is a discharge for spent matter, *b* is a pressure-gage, *c d* are openings for charging, *e* is the purifier, *f* the discharge for the exhausted materials of purification, *g* a stop-cock in the pipe *h* leading to the vessel *i*, which contains the water to be aërated.

Fig. 2174.

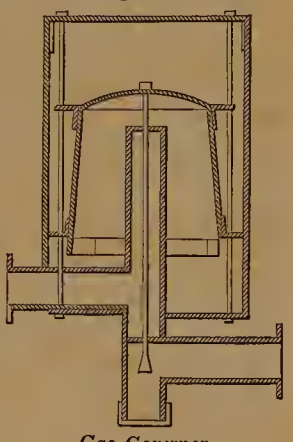


Vapor-Burner.

Of an allied character is that for producing the deutoxide of nitrogen for anæsthetic purposes. 4. A device belonging to a vapor-burner in which the liquid hydrocarbon passes from its reservoir into the chamber *b* between the plates *a a*, where it is vaporized by heat from the burner *f*. The vapor of the oil passes by the pipe *d* to the burner, and the flame is regulated by the thermostatic spring and plug *h i*.

Gas-gov'ern-or. The gas-governor is a small gas-holder into which the gas enters, and from which it is passed to the mains with a regulated pressure. The velocity of gas in the mains increases in the ratio of the square root of the pressure, so that by adding to this it may either be driven more rapidly or to a greater distance.

Fig. 2175.



Gas-Governor.

Gas-heat'er. An apparatus contrived for the application of gas to specific purposes of heating.

While every jet of inflamed gas will warm the surrounding air, it becomes necessary, in adapting it specifically for warming purposes, to change the jet from its usual position and in some other respects. In deference to the custom, the gas-heater is sometimes made to assume the forms of grate-bars or logs of wood in the usual fire-place.

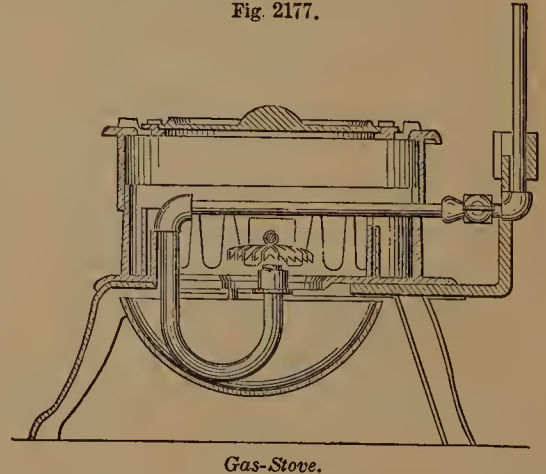
Fig. 2176.

Goddard's Gas-Heater.

Goddard's gas-heater has perforated bars in the form of a basket-grate, and over these is spread a quantity of asbestus, which makes an incandescent mass, resembling a coal fire.

In Fig. 2177, the air-regulating dish is formed in the segment of a sphere, and has its concave side upward. The influx of air is regulated by the vertical distance between the edge of the dish and the bottom of the stove. Above the frame is a rotating disk, consisting of a series of inclined sectoral wings, which distribute the heat.

Fig. 2177.

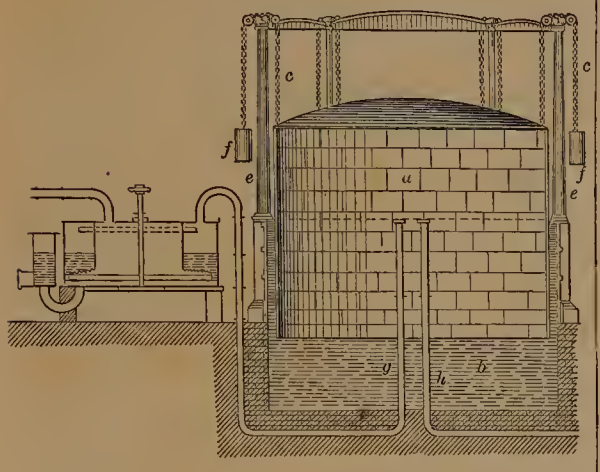


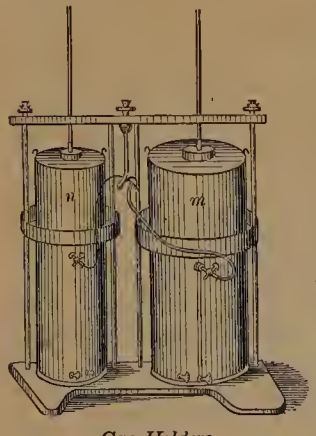
Gas-Stove.

Gas-hold'er. A large, vertical, open-bottomed cylinder *a*, inverted into a tank *b* of water, and used

for storing the gas from the retorts after purification. Its hight is usually equal to its radius, in accordance with the geometrical law that a cylinder having those proportions has the greatest capacity with a given surface.

Fig. 2178.





Gas-Holders.

Gas-holders are now made much larger than they were some years baek. A work on this subject, written a few years sinee, speaks in admiration of the Westminster gas-holders as having a capacity of 250,000 feet. We have far exceeded this.

Gas-holders are made of sheet-iron plates riveted together and daubed with tar inside and out to prevent leakage. They are stayed with rods and braces internally, and are suspended by chains *c* which pass over pulleys on the posts *e* whieh eneircle the holder. Weights *f* on the pulleys partially counterbalance the weight of the holder, the extra weight of the latter being the power which drives the gas through the mains and service-pipes to the burners of the distriet supplied by it.

Within the frame the holder ascends and descends as it is filled or emptied of gas, the lower edge remaining submerged in the tank to prevent the escape of gas. The gas is introduced and withdrawn through pipes *g h*, whose terminations are above the level of the water in the tank of the gas-holder.

Valves regulate the inlet and outlet apertures, so as to direct the gas into the holder, or to allow it to pass therefrom, as may be required. To prevent the freezing of the water in the tank, the surface of the water is covered with tar in the spaee between the outside of the holder and the side of the tank.

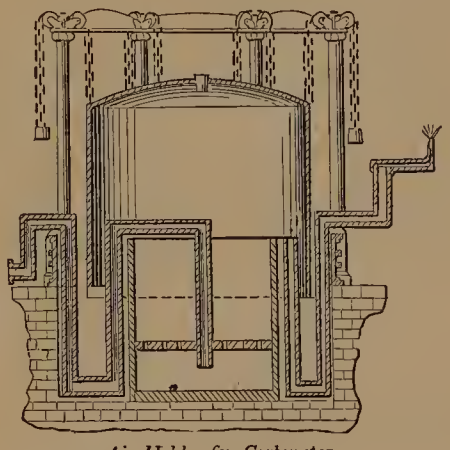
Gas-holders are made of various sizes, from 100,000 to 1,000,000 cubic feet eapaeity.

For laboratory and exhibitional use a pair of gas-holders is found useful, containing respectively oxygen and hydrogen gas. Their purpose in this conneetion for the exhibition of the oxy-hydrogen light, or the microscope illuminated by that means, requires that the hydrogen-holder *m* shall have double the capacity of the other one *n*, as the combining proportions of the two gases to form water is oxygen, 1, hydrogen, 2, by bulk. By weight the statement is very different: oxygen, 8, hydrogen, 1; oxygen being sixteen times heavier than hydrogen.

Gas-holders are sometimes made of flexible impervious bags, or sheet-metal cases. These require no partieular description.

The weighted gas-holder is the air-forcing device in some forms of carburetors, as in M'Avoy's. In the illustration, the tank *B a* contains the liquid hydrocarbon; the air comes in by pipe *c* to the lower part *a*, where it is distributed through the liquid by perforated plate *b*, and aseends into the holder *A*. It passes off by pipe *d* to the burner.

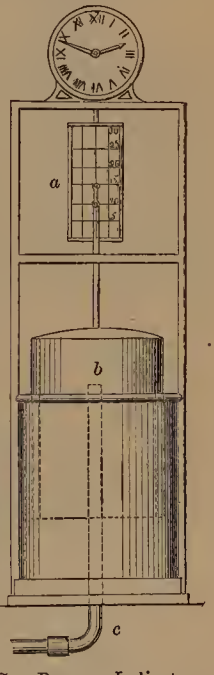
Fig. 2179.



Air-Holder for Carburetor.

Gas-in'di-ca'tor. This instrument is connected to the main pipe, and indicates by the rising and falling of a spring piston, or a weighted gas-holder *b*, the pressure of gas in the pipe *c*.

Fig. 2180.



Gas-Pressure Indicator.

A register is attached, having a peneil whieh rises and falls as the pressure varies; and as the peneil rests on a sheet of paper on a drum *a* traveling at a given rate, the diagram gives a faithful report as to pressure and time by the combined movements of the paper and pencil. A *gas-register*.

Gas'ket. 1. (*Steam-engine.*) A strip of leather, tow, or textile fabric, to form a packing or calk a joint.

2. (*Nautical.*) A plaited cord by which the sails, when furled, are bound close to the yards or gaffs.

Gas-light'ing Ap'pa-ra'tus. Devices for gas-lighting are matches, spongy platinum, fuse-pipe, eleetrophorus or voltaic circuit, elicitiug a spark, or heated platinum coil. See, in this connectiou, LIGHTING-DEVICES and GAS-BURNER.

Spongy platinum is heated to redness when exposed to a jet of hydrogen gas, and has frequently been used for this purpose. The effect is more immediate and certain when a stream of pure hydrogen is emitted temporarily, as in Fig. 2181, in whieh a small cylinder containing spongy platinum is attached to a gas-burner, which throws a stream of

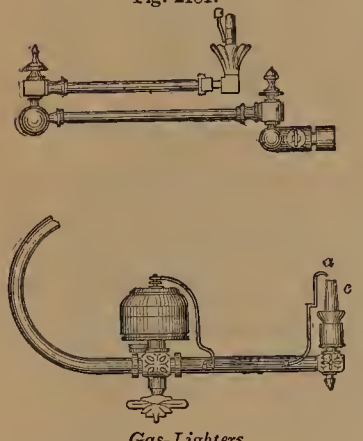
gas thereon to ignite the same. A mixture of pure and carbureted hydrogen is first passed through the pipe, and after ignition the flow of the former is stopped.

The *fuse-pipe* is a pipe leading from an accessible position to burners at a distance, and having a row of small openings throughout its length. Gas being turned on issues at these jets, and, a light being applied, runs along the pipe from jet to jet till it reaches the distant burners. It is then turned off.

Gas-lighting by electricity is adopted as a measure of convenience in reaching distant burners, or those in situations difficult to reach. Of the former character may be cited the circles of burners in the dome and rotunda and the cluster in the tholus of the Capitol at Washington; and of the latter the works at the royal arsenal, Woolwich, England, where all the burners are fixed upon the outside of the windows.

The means adopted are an electric spark produced by friction, as in the *electrophorus*, or a resistance body, such as a platinum coil placed in a voltaic circuit.

Fig. 2181.

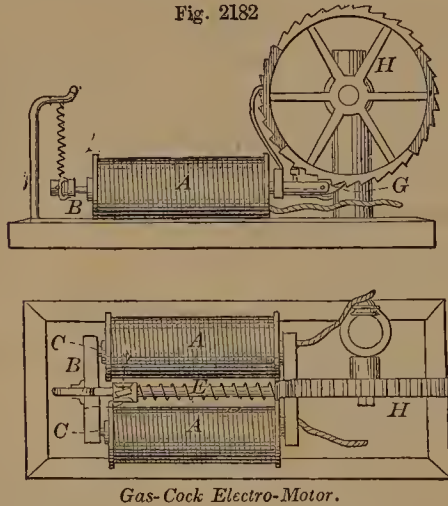


Gas-Lighters.

The electrophorus has assumed many forms: a glass piston in a metallic baton lined with Canton flannel; a pair of disks with cloth-lined faces, etc. (See ELECTROPHORUS.) Fig. 2181 shows one form in which the device is attached to the stop-cock, so that the act of turning the same to let on gas shall generate a spark at the break of the circuit between the point *a* and the tip of the burner *c*.

The other mode of gas-lighting by electricity is by means of a voltaic circuit. A battery is placed in any convenient place, and is connected by insulated copper wires with the burners. A coil of fine platinum wire, forming a part of the circuit, is placed above and a little on one side of the opening

Fig. 2182



Gas-Cock Electro-Motor.

in each burner, and this coil becomes heated by its resistance to the passing current, and so ignites the gas, which has been previously turned on. Or, a break may be made in the circuit immediately above the gas orifice, and the spark leaping across the interval lights the gas. These modes have been adopted in a number of legislative halls, public buildings, manufactories, and stores, on both sides of the Atlantic, and the electric current has been also the means of turning on the gas at the distant points by means of a ratchet-wheel on the axis of the gas-cock, which is turned by the successive pulsations of the armature, the latter being alternately actuated by electric connection and a retracting spring. This device is shown in Fig. 2182. The sliding rod *E* is a stem attached to the armature *B*, and has a click *G* which acts upon the teeth of the ratchet-wheel *H*, whose axis is the spigot of the gas-cock. When the voltaic current is passed through the coils *A*, the armature *B* is attracted, and the ratchet moved one tooth; the voltaic connection ceasing, the armature is retracted by the spring ready for another impulse.

On a less extended scale, the burners of a room may be connected with one pole of a battery and a wire hidden in a tassel with the other pole; when the wire is brought near to the burner, a spark leaps across the interval and lights the gas.

Clock-work has also been employed to turn on and light gas at a set time; and also to turn off the gas at a prearranged time.

Gas-main. A principal gas-pipe leading from the works, and having branches and distributing pipes.

See also *hydraulic main*, invented by Clegg in 1807, and forming a part of the gas-producing works.

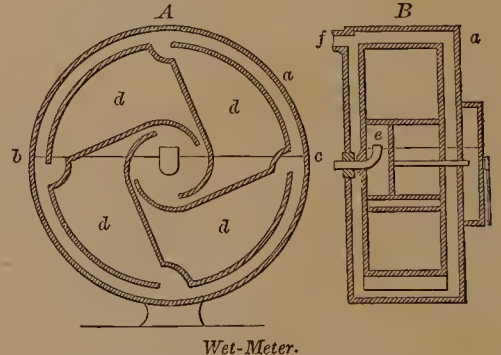
Gas-me'ter. A device for measuring the quantity of volume of passing gas.

Citizen Seguin, of the National Institute of France, described a gas-meter at the sitting of the Institute, October 6, 1797.

The wet-meter was invented by Clegg in 1807, and improved by Crosley in 1815. The dry-meter was invented by Malam in 1820, and improved by Defries in 1838. Many improvements and variations have been added since by various parties.

A (Fig. 2183) is a longitudinal and *B* a transverse section of the wet-meter, which is composed of an

Fig. 2183.



Wet-Meter.

outer box *a* partially filled with liquid, as water, alcohol, or glycerine, to the level of the line *b c*, somewhat above its center. Within this is journaled an axis carrying a series of buckets *d d d d*, each capable of containing a definite quantity of gas, which is admitted through the pipe *e* at the central part of the meter, and causes the buckets successively to rise, maintaining a continuous rotation. The gas passes out through a pipe *f* at the upper part of the meter, its quantity being measured by a series of multiplying gear-wheels; these derive their

motion from the axis on which the buckets are journaled, and register 100s, 1,000s, 10,000s, and 100,000s of feet, the amount being indicated on a series of dials.

Valves are arranged to cut off the supply of gas when the water in the meter rises above or falls below certain limits.

The constant-level meter has an automatic arrangement of float, which, as the water wastes by evaporation, descends and immerses an equal portion of its bulk, which is always equal to the quantity of water which has disappeared.

The principle of the dry-meter may be understood by describing it as a machine having a bellows of known capacity, and alternately filled with gas and emptied, the pulsations being counted by a register. Or it may be described as a cylinder with a reciprocating piston, whose motions are counted, the gas being discharged from the alternate ends of the cylinder as the piston reciprocates. The pressure of gas is the motor, and the changes of direction of motion are effected by induction and eduction valves, much as in a steam-engine.

Sugg's (English) photometric gas-meter is designed for experimental use, to show not only the volume of gas which has been consumed at the end of a given time, but also the rate per hour or per minute that the consumption is proceeding. It has two index-hands, one revolving once in a minute, and moved by clock-work; the other making a complete revolution during the passage through the meter of one twelfth foot of gas. The standard of the London companies is that the gas, when burned at the rate of 5 cubic feet per hour, shall give a light equal to the burning of 14 sperm candles, each consuming 120 grains in the same time.

Gas'o-line. A light grade of petroleum.

Gas-om'e-ter. The term is applied in England to a large vertical cylinder, closed above, and with its lower edge immersed in a water-tank, and used for holding gas. Such a vessel is more appropriately called a GAS-HOLDER (which see). The term *gasometer* probably arose from the fact that the *holder* is of known capacity, and as it rises affords so ready a means of estimating the quantity contained, thus constituting a *meter*. It is usual now to provide a *meter* in gas-works, whose duty it is to measure the gas on its way to the holder.

From gasometer has arisen the term *airometer*, when a vessel of similar construction contains atmospheric air. This is used in one form of blower, in ventilating-machines, in aspirators, machines for carbureting air, and for other purposes. See AIR-HOLDER.

Gas-oph'a-ner. An indicator of the presence of poisonous gases. It is described as a lump of boracic acid, heated to redness in chlorine, and blown into a bulb. Carbonic acid, sulphureted hydrogen, and other deleterious gases, give peculiar reactions on the bulb, and indicate their presence.

Gas'o-scope. An instrument for detecting the presence of carbureted hydrogen in the atmosphere.

It is used, or should be, in coal-mines, to give an alarm when a dangerous and explosive condition of the air supervenes. It may also be applied to detect a leak in the gas-apparatus of a building, or to give an alarm when Aminadab from the rural districts blows out the gas on retiring to bed at the hotel or at the house of his city cousin. See GAS-ALARM.

Gas-pipe. Gas-mains are laid in sections, the small end of one entering the wide socket of the adjacent section. A packing of hemp dipped in tar is driven in to form a joint; over this is a luting of clay, within which is poured hot lead.

Service-pipes are of various metals, wrought-iron tubing being now more common than any other. The sections of distributing-pipe have screw-socket couplings.

The mains are laid with a gradual slope, and at the foot of each incline, or where two descending slopes meet, a reservoir is formed to collect water of condensation. This chamber has an iron cover into which is fixed a pipe, which descends nearly to the bottom of the reservoir. At the summit of the pipe is a screw, which admits the attachment of a pump, by which the liquid in the reservoir is removed.

Gas-pipe Tongs. A wrench for screwing pipes into or out of their coupling. See PIPE-TONGS.

Gas-press'ure Reg'u-la'tor. See GAS-REGULATOR.

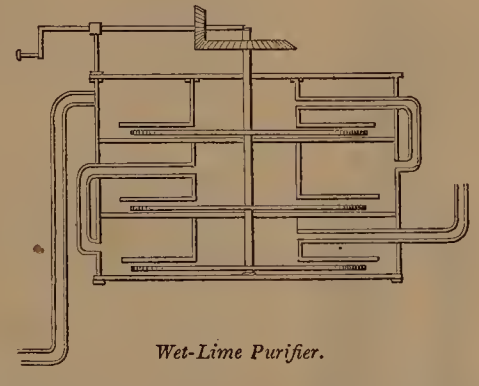
Gas-pu'ri-fi'er. An apparatus in which gas is purified of its sulphur compounds.

The purification of gas by passing it through lime-water is the invention of Mr. Clegg, England, and was introduced in 1807.

The ordinary illuminating gas, after having been evolved in the *retort*, its tar eliminated in the *condenser*, and its ammonia abstracted in the *washer*, is passed through the *purifier*, whose duty is to remove the sulphur and render the gas fit for consumption.

The wet-lime purifier has several chambers containing a certain depth of cream of lime. The gas passes through each chamber in succession, bubbling up through the liquid, the contact being rendered

Fig. 2184.



Wet-Lime Purifier.

more intimate by arms which rotate in the spaces through which the gas passes in flowing from one chamber to another. The arms also stir up the lime and prevent its settling.

The cream of lime absorbs the sulphureted hydrogen and carbonic acid, the water absorbs the remaining ammonia.

This process has been generally abandoned on account of the difficulty of disposing of the foul cream of lime known as "blue billy."

In the *dry-lime process* slightly moist hydrate of lime is placed on trays, or iron boxes, through which the gas is made to pass. This process is very effective, and has very generally superseded the wet-lime process. It removes the sulphur compounds and the carbonic acid equally well. When the foul lime is removed, however, it evolves the same odor of sulphide of ammonium which caused the wet-lime process to be abandoned. The suppression of this offensive odor has been effected by washing and special purification. The dry-lime meter has been generally abandoned in Europe, however, as was the wet-lime process previously.

The Laming process, now used in Paris, and generally over the continent of Europe, was introduced in 1849. The hydrated sesquioxide of iron forms a substitute for the lime. It is prepared of a

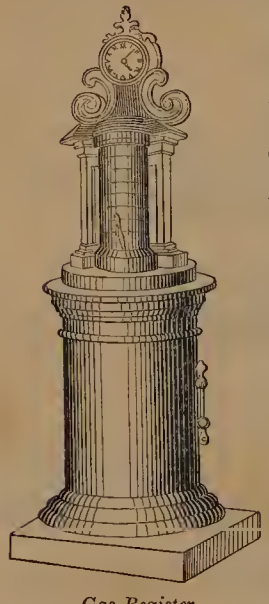
suitable quality by mixing copperas (sulphate of iron) with slacked lime and sawdust, and exposing the mixture to the air to oxidize the protoxide of iron to the sesquioxide. The resulting mixture contains hydrated sesquioxide of iron, sulphate of lime, and sawdust. When an excess of hydrate of lime is employed, the resulting mixture contains this substance also. This material is very effective in removing the sulphur compounds from the gas, and is not offensive when fouled with sulphur. The latter may be distilled to produce sulphuric acid.

The *iron-ore process* of Hill consists in the use of the natural hydrated sesquioxide of iron or bog iron ore, to which is added by the New York Gas-Light Company a quantity of iron borings and turnings moistened by ammoniacal liquor and exposed to the air. To the mixture is added pulverized charcoal. Other ores are used in Germany, where the oxides of iron are used in purification, to the exclusion of all the lime processes.

In some forms of apparatus for the purification of gases which are led through a liquid, a wheel with fans is made to revolve and keep the liquid agitated, while also exposing a large wetted surface to the passing gas.

Gas-reg'is-ter. An instrument by which the pressure of gas is indicated and recorded. The rate of pressure is not uniform, but varies with the season and the hour. An ordinary pressure during the day is $\frac{8}{10}$ of an inch; that is, a pressure which will raise a column of water in a tube to that hight. At night the pressure is increased according to the hour and the season; the quantity burned in winter is double that consumed in summer; more gas is burning at 9 P. M. than at 12 P. M.; and more at the latter than at 3 A. M. The rate being determined according to the judgment of the engineer, a man is placed in attendance, and a register records his doings. This pressure indicator is a cylinder covered with paper and revolved by clock-work. Against it rests the point of a pencil, which is acted on by the pressure of the gas in the mains, and records in a rising and falling line the changes in the pressure, while the vertical graduations of the paper answer to periods of time.

Fig. 2185.



Gas-Register.

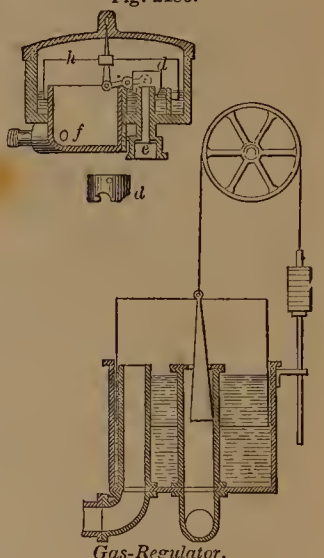
Gas-reg'u-la'tor. A device to equalize the flow of gas, notwithstanding varying pressure in the *main* and the variations produced by turning on or shutting off gas to or from burners in the building.

The valve *d* of the regulator is a cup with a notched rim inverted over the end of the inlet pipe *e* and connected by a lever with a larger cup *h*. The edges of cup *h* and valve *d* dip into annular troughs containing mercury.

As the pressure of gas increases, it acts upon the inside of the cup *h*, causing a depression of the notched edge of the valve *d* into the quicksilver. This decreases the opening through which gas can pass to the delivery pipe *f* in such proportion that at the extra pressure and speed an equal quantity will flow.

A decrease of pressure has a contrary effect, increasing the opening. The pressure of gas is beneath both the valve and the cup, but the latter being the larger overcomes the smaller and drives its edge into the quicksilver.

Fig. 2186.

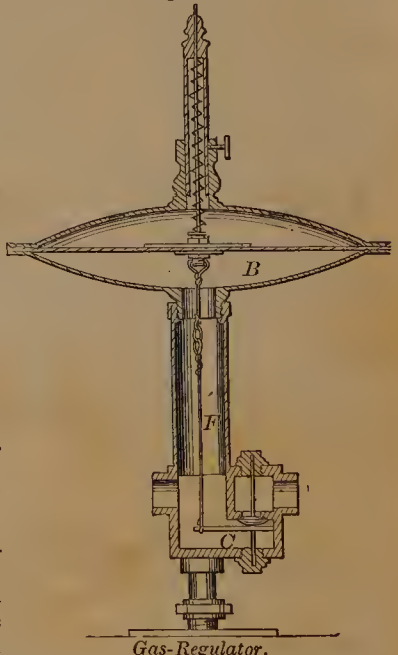


Gas-Regulator.

The larger view, Fig. 2186, has also an inverted cylinder which is partially counterpoised by a weight. As the pressure of gas at the inlet increases, the cylinder rises and carries with it the cone, which contracts the area of the gas opening in the plate on the summit of the central inlet-pipe; the pipe on the left is the exit.

Fig. 2187 shows a rubber diaphragm in a chamber wherein the pressure of gas raises the wire *F* and with it the lever *C* on which is the valve. Thus the extent of pressure in *B* determines the position of the valve relatively to its seat, and this graduates the area of opening to the pressure.

Fig. 2187.



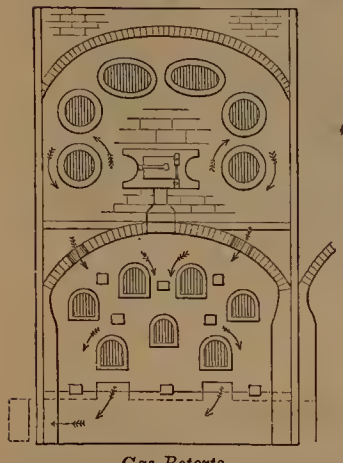
Gas-Regulator.

Gas-re-tort'. The chamber in which carbonaceous matter is distilled to produce illuminating gas.

Dr. Clayton distilled illuminating gas from coal in 1688; the "Philosophical Transactions" of 1739 refer to the fact. Dr. Hales in 1726 made a quantitative experiment as to the cubic inches of gas obtained from a given number of grains of coal. Lord Dundonald's patent of 1786 was for ovens or retorts in which coal was distilled. Murdoch in 1792 made lighting buildings by gas a success. See GAS.

Gas-retorts are made of iron or clay, and each in shape is a segment of a cylinder, the flat side forming the floor. These are set in a brick furnace, with their open ends presented outward ready for charging. This is quickly done by a peculiarly shaped scoop, which holds, say, 110 pounds of coal, and is handled by three men, as seen in the illustration. Being introduced longitudinally into the retort, it is upset, and deposits its load on the floor of the retort; a second scoopful makes up the charge, and the mouth of the retort is then closed and luted to prevent the escape of gas.

Fig. 2188.



Gas-Retorts.

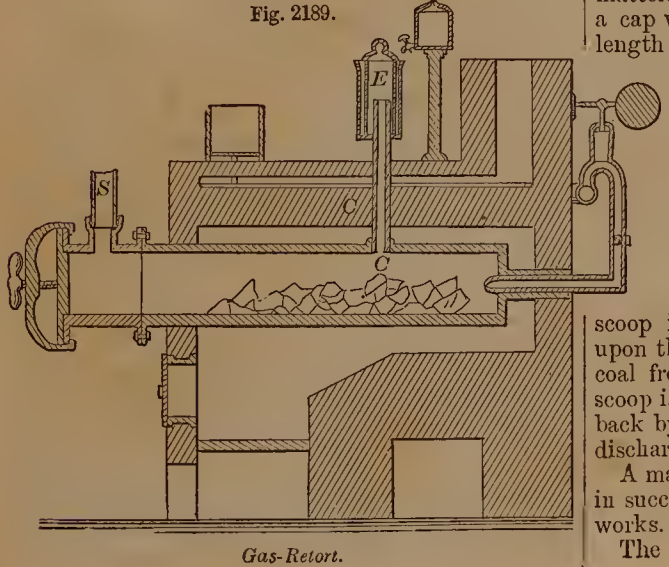
We have Mr. Watson's authority for stating that a retort holds 220 pounds, and that a bench of fifteen retorts is charged in fifteen minutes by three hands. The charge remains five hours in the retort; the coal is expanded to double its bulk and forms coke, but is much lighter, of course.

Some retorts are D-shaped in section, others are oval, and one is noticed having what is called a kidney shape, that is, a general elliptical form is varied by a longitudinal ridge along the bottom.

Croll's gas-furnace, Bow Common, London, England, has an upper series of 6 clay retorts, 18 feet long, constructed to be charged from both ends. The fire has a middle position, and the upper series are heated by the direct radiation from the fire, while the 7 lower retorts of iron, also double, are heated by the caloric current descending from the upper portion of the furnace.

The upper clay retorts are charged every four hours, and the lower iron ones every six hours. The average yield per day is 8,500 cubic feet per retort; $8,500 \times 13 = 110,500$ feet. Twelve of these furnaces are used at the Central Gas-Works, Bow Common, London, having a capacity for 1,326,000 cubic feet daily. The usual make of gas at these works is 900,000 cubic feet per day.

Fig. 2189.

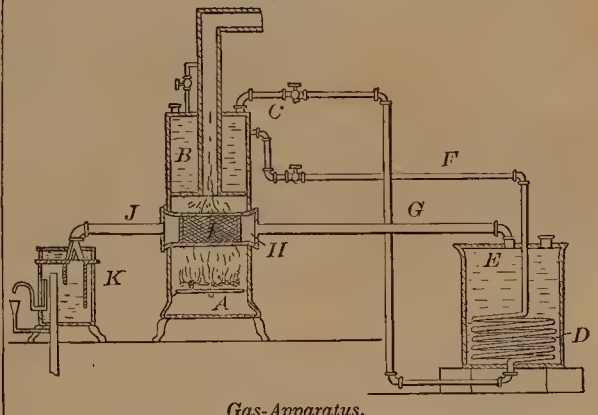


Gas-Retort.

Fig. 2189 shows a retort in which illuminating gas is made from tar introduced from vessel *E* into retort *C*. The tar passes through the water which is contained in the washing vessel above the retort, and which forms an hydraulic stopper to the retort. The steam is generated in pipes over the retort and passes into the latter. The retort is heated to redness and contains coke. A jet of steam is introduced at the rear pipe, and the carbureted hydrogen passes off at *S* to the main.

Fig. 2190 is an arrangement of mechanism for roasting hydrocarbon vapors, or changing them into permanent gases, by exposing them to heat while minutely divided or separated into small streams. The vapors generated in the vaporizer by steam from the boiler pass to the roasting-chamber. The vapor traverses the longitudinal perforations in the charcoal block, and is thus divided into streams to be more effectively acted upon by the heat. It then passes to the condenser.

Fig. 2190.



Gas-Apparatus.

A is the furnace, *B* the boiler, *C* steam-pipe to vaporizer *E*, which contains steam-coil *D*. *G* vapor-pipe to roasting-chamber *H*. *I* charcoal-block, which divides the stream of vapor. *J* pipe leading to condenser *K*.

Fig. 2191 is an arrangement for clearing the inner surface of the retort of the scale of carbonaceous matter. The gas-retort is filled with limestone, and a cap with an air-pipe extending nearly the whole length of the retort is luted thereupon. The cap of the ascension-pipe is removed, and a current of air being established through the retort, the "scurfing," or removal of the carbonaceous coat of the inside of the retort takes place simultaneously with the elimination of carbon from the limestone, producing quicklime.

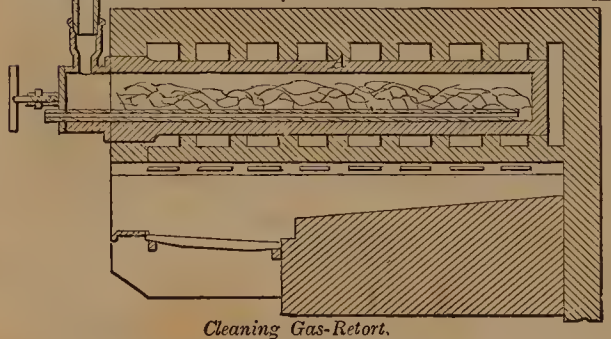
Gas-re-tort' Charg'er. An apparatus for introducing the charge of coal into a retort or removing the coke therefrom. The scoop is sustained on swivel and sliding bearings upon the truck, which runs on a track, and conveys coal from the heap to the bench of retorts. The scoop is run into the retort, and the bottom is drawn back by the rod extending beneath the handle; this discharges the coal.

A machine for this purpose has been for some time in successful operation at the Dublin, Ireland, gas-works.

The method of working is as follows: One man

takes off the lids of the retorts of one row, the drawing-machine moves opposite to one retort, sends in the rakes, at one draw brings out the coke, and then moves on to the next retort, and the charging-machine comes up to the discharged retort and puts in the charge of coal. The scoop is made double, and

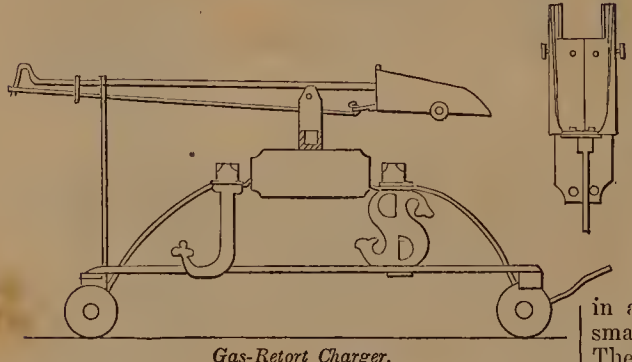
Fig. 2191.



Cleaning Gas-Retort.

forms two small scoops hinged together, and discharging in opposite directions; so that, in turning, the coals are spread well over the surface of the retort, thus utilizing the greatest amount of heating surface in the rein. As the retorts are charged,

Fig. 2192.

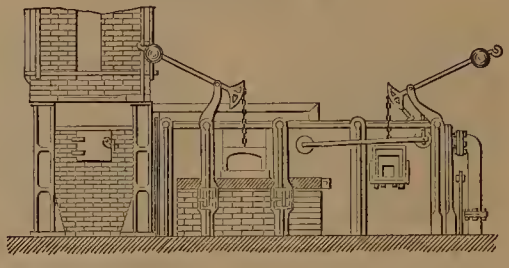


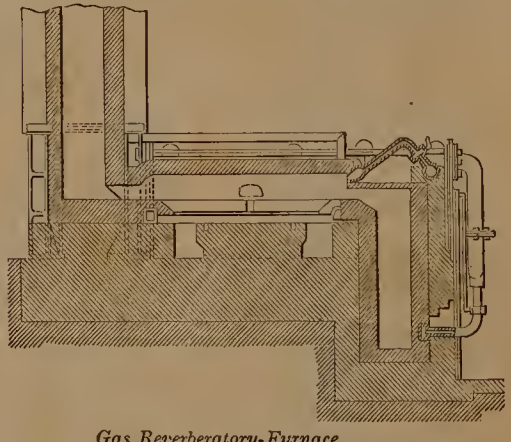
Gas-Retort Charger.

the man who preceded the drawing-machine and took off the lids now follows the charging-machine, closing the retorts. Two boys drive the machines, one man fills the coal into the hopper, and another attends to the taking off and putting on of the lids or doors. The platforms of the machines are now altered to the level of the row of retorts to be drawn and charged next, and those operations proceed as before. By these arrangements, the retorts are exposed to the action of the atmosphere a much shorter time than in the case of hand labor, as the stokers generally "slack out" ten or a dozen doors at once, and draw them all before charging any, thus leaving the first-drawn retort a long time to the cooling atmosphere, whereas with the machine the retort is charged directly it is emptied, — an advantage that must be appreciated by all gas-engineers. The work of drawing and charging is done with a regularity that cannot be attained by manual labor; the retorts are supplied with the maximum quantity of coal they will take, and the quantity does not depend upon the caprice of a scoop-driver. The coke must be raked out clean and a quantity cannot be left in, as is often the case with manual labor when the eye of the foreman is not on the men.

Gas Re-ver'ber-a-to'ry-fur'nace. An iron-refining furnace in which gas from bituminous coal is caused to pass over the molten metal, depriving it of carbon. The upper is a front view, and the lower a longitudinal section of the apparatus. The generator is partially filled with coal which is ignited, a sufficient quantity added to fill the generator, and the opening is bricked up. The metal, broken into pieces of suitable size, is placed upon the hearth, and the inflamed gas is directed downwardly upon it by tuyères. A limited quantity of air is also admitted to the generator by pipes. The metal, when

Fig. 2193.





Gas Reverberatory-Furnace.

in a state of fusion, is stirred occasionally, and a small quantity of limestone added from time to time. The treatment lasts from two and a half to five hours, according to the quality of iron produced, and the metal is drawn off in a fluid state. The fire is allowed to die out, and the generator cleaned at intervals of about fourteen days.

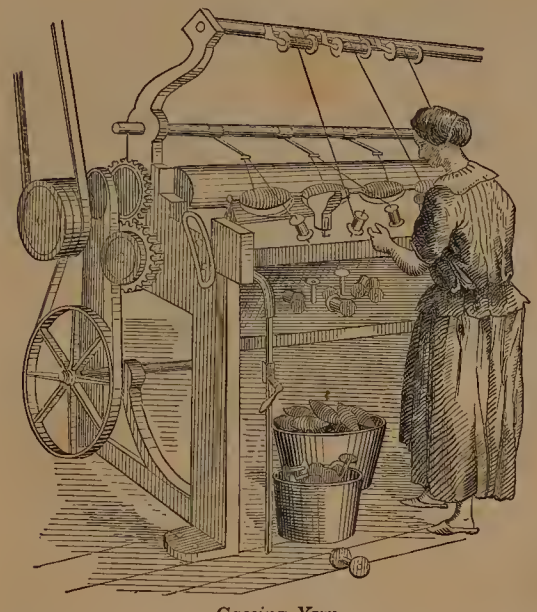
Gas-ring. A thin plate of steel or copper, perforated to the exact size of the caliber of the gun, and used as a face-plate to the breech-block in Sharp's breech-loading rifle and Broadwell's breech-loading ordnance, adopted by the Prussian government. The breech-block is chambered out larger than the hole in the plate, so that the gas from the explosion of a charge in the gun flies back into the chamber and presses the plate or ring forward against the breech of the gun. A *gas-check*.

Gas'sing. (*Cotton-manufacture.*) The process of burning the divergent fibers or *fluff* from yarn. The loose filaments are burned off by passing the yarn quickly through a gas-flame. The yarn is thus prepared for thread, lace, and hosiery. An average yarn loses about one eighteenth in the operation.

The *gassing-frame* has a row of jets about twelve inches apart, and a little hood above each. The yarn is led from one bobbin to a second, which is rotated by being pressed against a rotating roller. The yarn in passing between the spools traverses back and forth through the flame passing over pulleys.

On emerging from the flame the yarn is cleaned by a brush and passes through a notch in a piece of brass, which is arranged to detect any knot or lump

Fig. 2194.

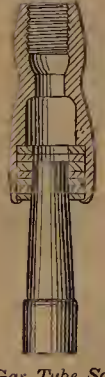


Gassing Yarn.

in the yarn. A defect of this character depresses the brass, and instantly turns aside the gas-burner, so that the yarn is not burnt during the temporary stoppage; the defect being remedied by the minder, the parts are restored to their normal position and the operation proceeds.

Gas-sock'et. The metallic socket which slips over the tip of a burner, and connects the elastic gas-tubing therewith.

Fig. 2195.



Gas-Tube Socket.

Gas-stove. One usually made of iron, and may be partially lined with fire-brick.

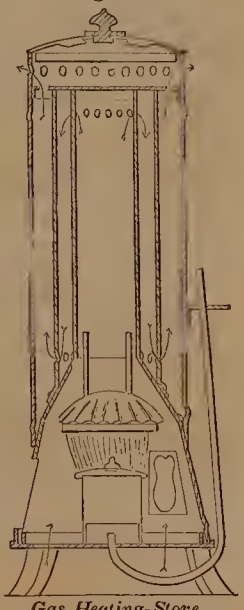
Fig. 2196.

Gas Cooking-Stove.

Branches 1, 2, 3, 4, 5, from the main pipe *a* are carried to the upper part of the stove and to the bottoms of the various interior compartments designed for roasting, baking, etc. These terminate in circularly arranged tubes, provided with minute burners, over which the vessel containing the article to be cooked is supported.

Fig. 2197 is a heating stove in which the gas is turned on to the perforated top of a gas-chamber, and over this a corrugated conical cap is suspended from an upright flue, the product of combustion flowing into and around this cap up the flue, and through holes in the side at top, down another flue as far as the cover of the combustion chamber, and thence through the apertures into and up a third flue to the top of stove. The flues are formed by spaces between three cylinders of different diameter; a plate at the top covering the inner flues has perforations over the outer flue.

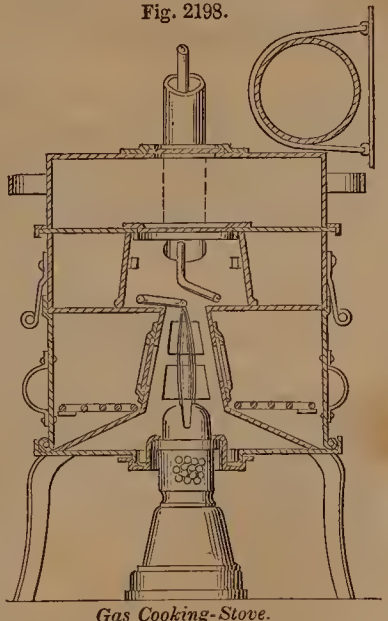
Fig. 2197.



Gas Heating-Stove.

Fig. 2198 is a gas cooking-stove which has a square sheet-iron stove, to be used with a kerosene lamp, or a gas-burner, having on each side an oven for baking, etc., which is surrounded on all sides, except the outside and ends, by a flue, in which the products of combustion circulate. On the top of the stove are holes in which the cooking utensils are placed, and a pan for baking may also be placed thereon. By means of dampers the products of combustion may be prevented from circulating beneath the top, and made to pass directly out of the chimney. On one end of the stove is a boiler in which to generate steam, which is conveyed off by pipes to perform various culinary operations. Pieces of mica are let into the stove in various places to expose the light and also to give a view of the interior of the ovens.

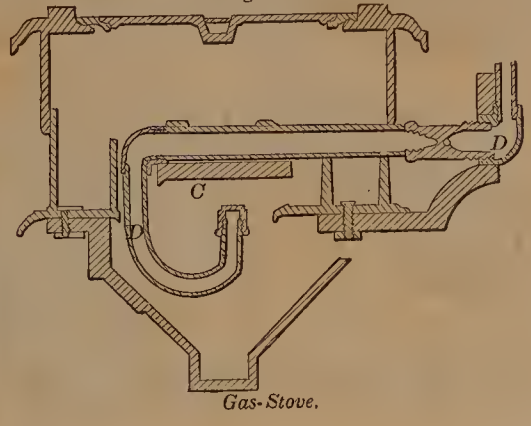
Fig. 2198.



Gas Cooking-Stove.

Fig. 2199 is a gas-stove in which the heat of the burning jet is made to vaporize coal-oil in the pipe *D*. The generating chamber is of a metal less liable to oxidation than cast-iron, and is protected by a movable plate beneath, which is suspended over the surface of the burning hydrocarbon. The heat is concentrated by an annulus *C*, which encloses the combustion chamber. A fire-cup beneath the burner catches the waste oil.

Fig 2199.



Gas-Stove.

Gas-torch. A lighter for gas. See LIGHTING-DEVICES; ELECTROPHORUS.

Gas-wash'er. This apparatus receives the gas from the condenser, which removes the tar. The office of the washer is to remove the ammonia, which affects the quality of the gas and is otherwise injurious. Several forms of washers are known. The essential features consist of devices for bringing every particle of the gas into contact with water, for which the ammonia has a great affinity. The effectiveness of a particular machine is in proportion to the intimateness of the contact of the gas and water therein. Dr. Watson, Bishop of Llandaff, announced the fact in 1750, that the inflammability of gas was not affected by contact with water. The *washer* is the third in the series of gas-making apparatus. (See GAS-MAKING.) Mr. Croll, an English gas-engineer, is credited with the invention of the gas-washer now in use.

Eight or ten gallons of ammoniacal liquor are extracted from the gas produced from 2,000 pounds of coal, and it is treated by manufacturing chemists, who extract about fourteen ounces of sulphate of ammonia from one gallon of the liquor.

Gas Weld'ing-fur'nace. (*Metal-working.*) A heating jet, or cluster of jets, to heat pieces of metal locally, in order to bring them to a welding temperature. See GAS BLOW-PIPE.

Gate. 1. A barrier which may be opened to permit passage; as, —

Canal-lock gate.	Sluice-gate.
Farm-gate.	Turnpike-gate.
Flood-gate.	Water-gate.

Some of which are considered under their alphabetical order.

a is a gate with adjustable hinges, operating on rings on the post; the fastening consisting of a movable latch and staple.

b shows a mode of setting up the gate when the outer end sags, by means of the diagonal strut.

c shows another form of setting up the outer end by means of a tie slat.

d is a gate whose top bar is pivoted on the post, the gate being counterweighted by a box of stone on the extended bar.

e is a gate which slides longitudinally, its slats traversing on rollers.

f is also a sliding-gate, which has rollers to keep it level, whether open or shut.

g is a gate which slides half its length and then rotates on a bar at its midlength.

h is a gate of pivoted bars on the principle of the lazy-tongs.

i is a gate having a set of pivoted slats, which assume a vertical position when the counterweighted top slat is allowed to oscillate.

j is a suspended gate, which swings upward broadside in a vertical plane.

k is a gate suspended from pulleys, and counterweighted.

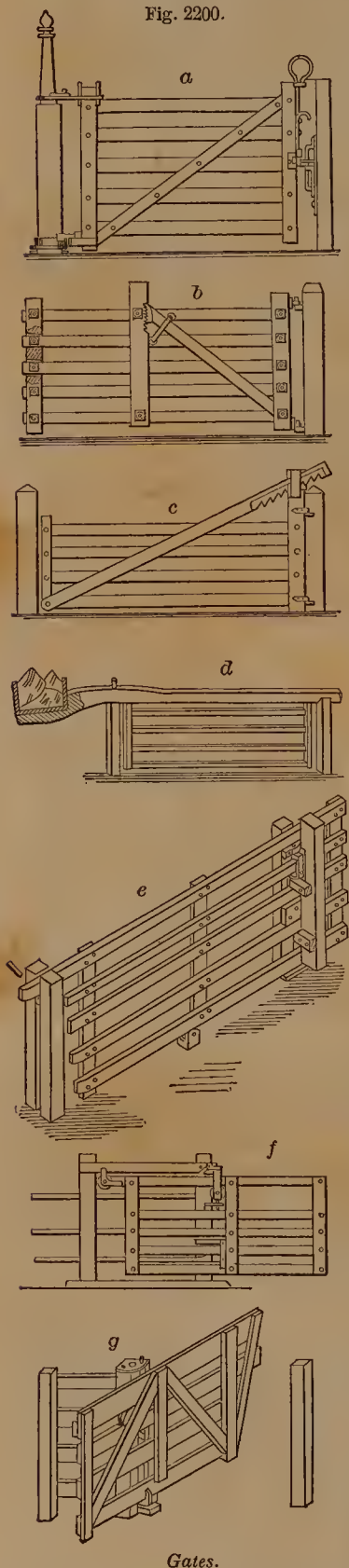


Fig. 2200.

Gates.

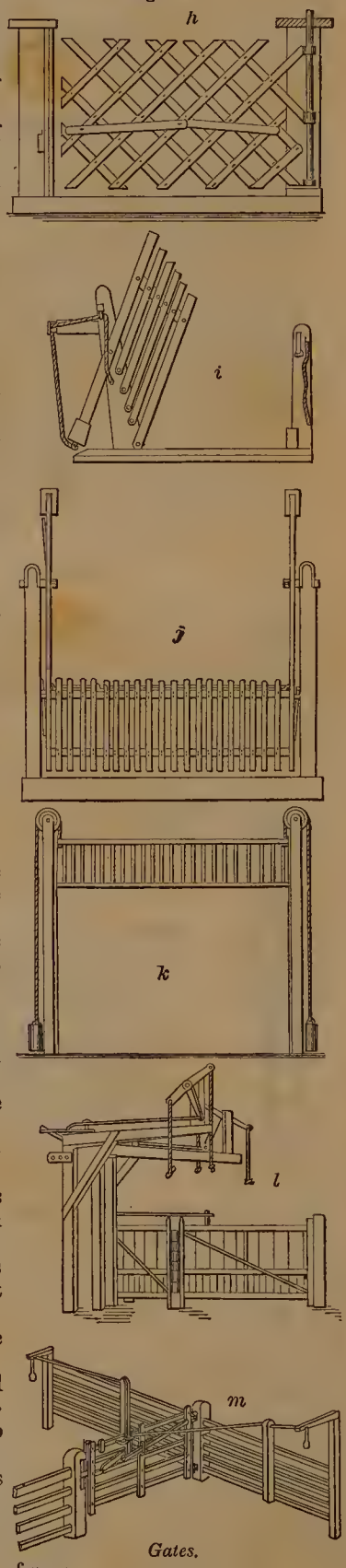


Fig. 2201.

Gates.

l m are gates operated by equestrians or persons in vehicles by means of ropes.

2. (*Locksmithing.*) One of the apertures in the *tumblers* for the passage of the *stub*.

3. The valve which admits the water to the bucket of the WATER-WHEEL (which see).

4. (*Founding.*) *a.* An *ingate*. The aperture in a mold through which the metal is poured. The *runner* conducts the metal from the *ingate* to the hollow in the mold, where it forms a *casting*. The piece of metal which occupies the *ingate* and *runner* is called a *sprue*, and is knocked off the casting.

b. The sprue or piece of metal cast in the gate. A sullage-piece.

Gate-cham'ber. (*Hydraulic Engineering.*) A recess in the side wall of a canal-lock, which receives the opened gate, so that it shall not project into the lock-chamber.

Gate-chan'nel. (*Founding.*) The *gate*, *geat*, or *git*, through which molten metal is admitted to the mold. See GATE.

Gate-hook. A gate-hook is that part of a gate-hinge which is driven into the post and sustains the leaf attached to the gate.

Gate-post. One to which a gate is hung or which it shuts against, and which are known respectively as the *swinging* or *hinging* post, and the *shutting* post.

Gate-saw. A mill-saw which is strained in a *gate* or *sash* to prevent *buckling*.

Gate-shut'ter. (*Founding.*) A spade or paddle which closes the channel against the molten metal when the mold or bed is full, and turns it in another direction to other molds or beds.

Gath'er. 1. (*Vehicle.*) The inclination forward of an axle journal, or spindle, usually one tenth of its diameter.

The amount of gather depends upon the amount of taper. A perfectly cylindrical spindle requires none.

The inclination downward is also dependent upon the taper, and is called the *swing*. The latter renders the *dishing* of the wheel necessary, in order that each spoke as it comes to the bottom position may be vertical. See SWING; DISH.

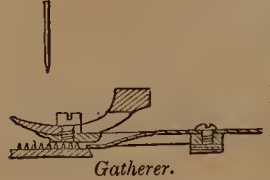
If a taper spindle be made without any *gather*, the tendency of the wheel is to slip outward against the linchpin or nut. If the *gather* is in excess, the *boxing* of the *hub* rubs hard against the *butting-ring* of the axle.

2. (*Bookbinding.*) To collect and place in consecutive order the printed sheets of a book. The pile of sheets is *folded*, *gathered*, *collated*, *stitched*, and *bound*.

3. (*Needlework.*) To draw into plaits or folds by means of a thread or cord.

Gath'er-er. (*Sewing-machine.*) A device which brings the cloth together in folds or plaits, so as to be sewn in crimps. It may consist of a tongue whose end pushes against and puckers up the material in advance of the action of the needle. In the example, Fig. 2202, the device is attached to the presser foot. The upper and lower pieces of cloth are separated by a metallic tongue, so that the feed-bar acts first upon the lower piece and gathers the same. The two pieces of cloth are then forwarded together beneath the presser.

Fig. 2202.



Gatherer.

There are numerous varieties. See Gregory's "Sewing-Machine Attachments," Washington, 1872. The ruffler acts upon the same principle.

Gath'er-ing. 1. (*Bookbinding.*) The selection and arranging of a set of sheets according to signatures, to form a book. See GATHER.

2. (*Carpentry.*) An assemblage of beams supporting a scuttle.

Gath'er-ing-board. (*Bookbinding.*) A horse-shoe-shaped table on which signatures are laid to be gathered or assembled to form a book. A more convenient way is to arrange the signatures on a long straight table, the first half on one side and the latter half on the other, so that the gatherers may follow each other consecutively, "knocking up" and depositing the complete book on an adjoining table.

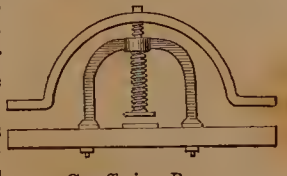
Gath'er-ing-hoop. One used by coopers to draw in the ends of the staves so as to allow the hoop to be slipped thereon.

Gat'ling-gun. A machine-gun which has a cluster of barrels and a charging breech at which the cartridges are automatically loaded into the barrels and fired in succession. See BATTERY-GUN.

Gau-din'o-type. (*Photography.*) A process named from its French discoverer, Gaudin.

Gauf'fer-ing-press. A press in which pieces of fabric cut to the shapes of leaves, petals, etc., are pressed between dies to confer the ridges, indentations, creases, and other irregular features of the natural object.

Fig. 2203.



Gauffering-Press.

The ancient Egyptians gauffered their linen by pressing it between fluted boards.

Gauf'fer-ing-tool. A tool for giving the roundness, fluting, crimping, or other peculiar form to leaves, petals, calyxes, etc., for the construction of artificial flowers and sprays.

The hand tools are spherical, conical, pyramidal, hooking, or cylindrical, and attached to handles, the working faces being heated to deliver the impression or indentation.

Other tools are stamps with counterpart convex and intaglio faces, between which is stamped the piece of fabric which has been previously cut to a shape.

The material is cambric, jaconet, and fine muslin, crape, gauze, taffeta, satin, and velvet, according to the natural appearance of the flower represented.

Various other materials are necessary, — silk thread, wire, wax, beads, floss-silk, chenille, gum-water, starch, gold-leaf, kid, colors, nap of cloth, etc.

Gauge. A measuring device. See GAGE.

Gaunt'let. An armed glove, anciently of mail or leather, with metallic shells or scales.

Gaun'tree; Gawn'tree. A trestle for casks.

Gauze. (*Fabric.*) A light, transparent silk or cotton goods. Said to be named from Gaza, in Palestine, from whence it was introduced.

In gauze-weaving, between every two casts of the shuttle, the warp-threads are turned or twisted after receiving the woof from right to left, and the reverse, alternately, between each throw of the shuttle, so that the weft threads, represented by black dots in the figure are separated from each other, and a light, transparent texture produced.

Fig. 2204.

Gauze-Weaving.

Gauze Wire-cloth. A textile fabric, either plain or twilled, made of brass, iron, or copper wire, of various degrees of fineness. Used for sieves, safety-lamps, respirators, etc. Brass-wire gauze was shown in the French department of the London

Exhibition of 1851, having 67,600 meshes to the square inch = 260 parallel threads in a linear inch.

Gav'el. 1. Originally, a small parcel of grain in the straw. Now, enough of the grain to be bound into a sheaf; the grain is raked from the harvester platform in *gavels*. Binding makes it a *sheaf*. A stook, or collection of sheaves placed on end, leaning together and mutually supporting, is a *shock*.

2. A mason's setting maul.

3. A presiding officer's mallet.

Gav'e-lock. An iron crow-bar.

Gay'di-ang. A vessel of Anam resembling a junk. It carries two or three masts with triangular sails.

Gaze-a-Blu-toir'. (*Fabric.*) A thin silk gauze, made in France, for bolting cloths.

Gaz-o-gene'. A portable fountain or soda-water apparatus. See Fig. 45, p. 18.

Ga-zon'. (*Fortification.*) A piece of sod used as a revetment or lining for parapets and earthen banks.

Gear. A general term which may mean: —

1. Arms ("ready all his *gere*," Chaucer), *accouterments* ("armours and al other *gere*, *Yvaine and Gawin*," Ritson), *clothing*, *dress*, *trappings*, *harness*, *chafing*-gear.

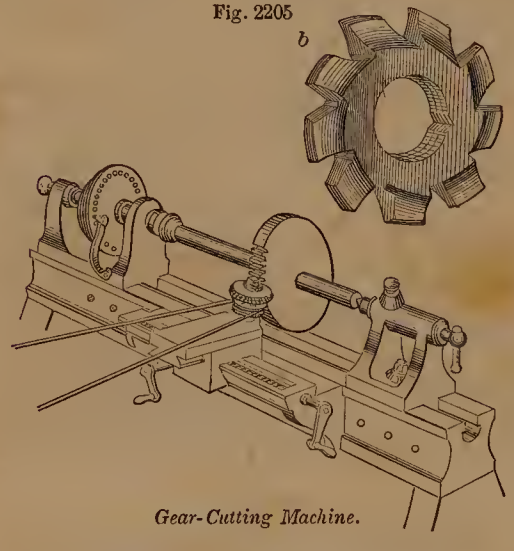
2. Furniture, rigging, tackle (*jeers*), apparatus, the appurtenances of an implement: e. g., *expansion*-gear, *valve*-gear, *pump*-gear, *plow*-gear; the working parts of a locomotive; the rigging of a spar or sail; the running parts of a wheeled vehicle, as the *fore-gears*, *hind-gears*, referring to the *fore*-axle and its wheels, the *hind*-axle and its wheels. To the former is attached the tongue and fore hounds, to the latter the hind hounds. Each carries its bolster.

3. A cog-wheel. See GEARING.

Gear-cut'ting Ma-chine'. One for making cog-wheels by cutting out the interdental material. Invented by Henry Mandslay.

In one form of this machine, the disk to be cut is fixed on a spindle or mandrel, to whose end is at-

Fig. 2205



Gear-Cutting Machine.

tached a graduated dividing-wheel. This wheel has a number of circles, each having its own series of graduations, at which are holes with which the stop-pin engages to hold the blank while the circular cutter on the slide-rest does its work. This cutter has a shape coinciding with that of the interdental space of the wheel required, as shown in the enlarged view *b*. The mandrel of the cutter-wheel is rotated by a band, and the cutter is fed by a hand-crank and feed-screw, so as to traverse past the face of the wheel under treatment.

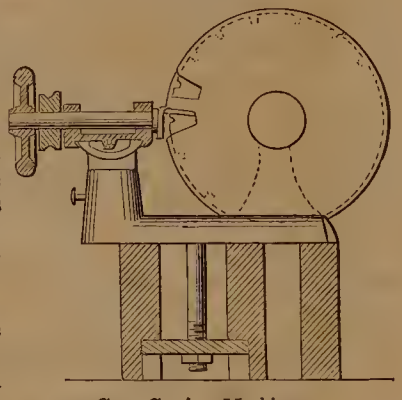
The face of the dividing-wheel, as has been stated, has various circles of graduations, which afford the means of giving a great choice of number of cogs to the wheel on the spindle.

Circles graduated as below are divisible by the numbers attached, and divide a wheel for the corresponding numbers of teeth: —

Number of teeth.	Graduations.										
	192	200	208	216	220	224	252	256	272	304	360
	192	200	208	216	220	224	252	256	272	304	360
	96	100	104	108	110	112	126	128	136	152	180
	64	50	52	54	55	56	84	64	68	76	120
	48	40	26	36	44	32	63	32	34	38	90
	32	25	13	27	22	28	42	16	17	19	72
	24	20		18	11	16	36	8			60
	16	10		12	10	14	28				45
	12	5		9	5	8	21				40
	8			6		7	18				36
	6						14				30
							12				24
							9				20
							7				18
							6				15
											12
											10
											9
											8
											6

Fig. 2206 shows a machine for cutting wooden gear, or patterns of cog-wheels for easting. Arranged on a lathe-bench is a sliding cutter-carriage, having a revolving cutter of the shape of the side of the tooth, so that as it revolves it cuts the space between two teeth; a graduated dividing-plate governs the spaces between the teeth.

Fig. 2206.



Gear-Cutting Machine.

Gear'ing. Wheels with cogs to transmit power.

The term is also applied to other mechanical devices by which motion is transmitted; as, *change-gear*, *chain-gear*, *back-gear*, *overhead-gear*; or by which parts are operated, as *valve-gear*, *hoisting-gear*, *expansion-gear*. Also to other devices involving an assemblage of parts, as *running-gear* of a wagon.

Archimedes was acquainted with toothed wheel-work before the Christian era.

Thomas Young does not doubt that Ebn-Junis, at the end of the tenth century, had applied the pendulum to the measurement of time, but ascribes the first combination of the pendulum with wheel-work to Santorio, in 1612.

The hydraulic clock of Ctesibus, under Ptolemy Energetes II., which gave the civil hours throughout the year at Alexandria, was, according to the description of Vitruvius, a real astronomical clock; a very complicated hydraulic machine, working by means of toothed wheels. It is not improbable that the

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